The American Midland Naturalist

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IN MEMORIAM

Dr. Theodor Holm

Dr. Theodor Holm

▽

Born: Copenhagen, Denmark, February 3, 1854.

Died: Providence Hospital, Washington, D. C., December 26, 1932.

Graduated under Warming from the University of Copenhagen in 1880. He was appointed to the Denmark North Pole Expedition in 1882 as botanist and zoologist under Admiral Garda. The ships were frozen in the Greenland ice for about two years. Notwithstanding this he added greatly to the botanical knowledge of West Greenland. His great knowledge of altitude and the circumpolar floras compelled attention from all interested in this subject.

Dr. Holm came to New York City April 12, 1888 and as soon as possible applied for citizenship. He enjoyed telling us that he was an American by choice.

For drawings that show the anatomy of medicinal plants, he had no peer. He read all the teutonic languages and many Latin ones. His garden was a jungle of rare, wild things, azaleas, violets, etc.

Dr. Holm was a gracious and genial host. He gave interesting dinners and could cook on occasion. He moved to an isolated farm in Maryland in order to have uninterrupted time for his work. He was finally persuaded to accept a place on the research staff of The Catholic University where he was given ample room for his collections.

Many of Dr. Holm's papers were published in Germany. It does seem regrettable that we shall have to reach his American botanical work through translation or reviews.

He would take infinite pains to help good work, but for pretense and bad work, his criticism was devastating. One wishes there were other botanists so little dull.—C. H.

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LEAF STRUCTURE OF RHODODENDRON CATAWBIENSE MICHX.

Grown in Picea-Abies Forest and in Heath Communities

STANLEY A. CAIN AND J. D. OLIVER MILLER

During the past five years the writer has been interested in members of the order Ericales which are abundant, both as to numbers and species, in the Southern Appalachian Mountains, *especially* in the Great Smoky Mountains which are the highest and least disturbed. Especially interesting are the

Fig. 1. Brushy Mt. Bald, showing the general physiognomy of one of the more extreme heath balds. Elevation about 5,000 feet. *Rhododendron catawbiense* **Michx.** is the conspicuous large-leaved shrub in the center. Photo by S. A. Cain.

treeless communities, fig. 1, mainly in exposed or burned places in the sub-alpine zone, which are dominated by species of Ericales such as *Rhododendron catawbiense* Michx., *R. punctatum* Andr., *R. maximum* L., *Kalmia latifolia* L., *Dendrium prostratum* (Loud.) Small, *Vaccinium corymbosum* L., *Hugeria erythrocarpa* (Michx.) Small, *Menziesia pilosa* (Michx.) Pers., etc.

A considerable quantity of material for ecological comparisons of anatomy has been collected, from which this study on *Rhododendron catawbiense,*[1] and the following by Mr. Duncan, on *R. punctatum,* are the first reports. The anatomical work is preliminary to physiological and transplant studies which it is hoped can be carried out in time. For that reason the relation of these xeromorphic structures to vital processes is reserved for later consideration. This study compares the leaf structure of a single species grown under the protection of the sub-alpine spruce-fir (Picea rubra-Abies Fraseri) forest, fig 2, and the heath bald communities where exposure is

Fig. 2. Maximum development of the Picea rubra-Abies Fraseri association near Indian Gap. Elevation about 5,000 feet. Rhododendron is scattered in as dense a stand as here illustrated but increases in abundance with elevation. Photo by S. A. Cain.

[1] The senior author is responsible for this paper except for the preparation of slides and one set of measurements.

much greater. In transitional regions, between the balds where *Rhododendron catawbiense* is one of the dominants in the superior stratum, and the denser, taller forest where the Rhododendron is scattered, it forms one of the dominants in the shrub stratum. These communities have been described by Davis (1930) and by Cain (1930 and 1931). The following data on the environment have been taken from the latter publications.

For several weeks during the summers of 1928 and 1929 evaporation rates were recorded from the spruce-fir forest and an heath bald on Mt. LeConte in the Great Smoky Mountains, at an elevation of approximately 6,600 feet. In 1928 the average weekly summer loss from Livingston spherical atmometers was 34.6 cc. while the average loss under the forest cover was only 7.3 cc. per week. The ratio, B/F, in this case is 4.7. In the summer season of 1929 the average rates were higher; 82 cc. in the bald and 14 cc. in the forest, or a ratio of 5.9. Although the loss from the atmometers is considerably higher in the bald than in the forest it will be noticed that the average evaporating power of the air in ex-

Fig. 3. A close view of the species grown in the forest habitat. Photo by S. A. Cain.

posed places is relatively low. This is due to the cool temperature and high relative humidity, since clouds settle over the upper slopes practically every day, whence the appropriate name of the mountains.

The following samples of air and soil temperatures will show further the contrast in habitats occupied by these species. Air temperature on August 7, 1928 reached a peak in the heath bald of 69 degrees F. at 2:00 p. m., while in the spruce-fir forest the temperature was 62 degrees F. On the same day the peat soil in the heath bald reached a peak of 60 degrees F. at 4:00 p. m., while the peat soil in the forest reached only 56 degrees F. These temperatures represent an average of the upper three inches as measured by the ordinary copper-nosed soil thermometer. In the heath bald where the peat soil had been eroded away the dry sandy subsoil was much warmer, reaching 82 degrees F. at 2:00 p. m. Two years later, August 9, 1930, another temperature record showed the air temperature of the heath bald to reach a peak of 96 degrees F. at noon while it was only 75 in the forest a short distance away. The peat soils showed temperatures of 70 and 55 degrees, respectively. These records are sufficient to show the cooling effect of the forest cover and the high moisture of the peat soil. Summer temperatures of 90 degrees are not rare in the middle of the day but are exceptional as damp cool weather prevails. Winter temperatures of 18 degrees F. below zero are occasional but of short duration. Sudden changes of temperature of great magnitude are common. Snow does not usually remain on for any length of time but the soils remain frozen most of the winter except for shallow thaws.

A brief and inconclusive study of relative transpiration rates of *Rhododendron catawbiense* by the cobalt chloride paper method, as improved by Livingston, indicates a much higher rate of water loss per unit area of leaf surface in the heath bald. Four tests were made on a leaf from each habitat. The plant growing in the heath bald gave an average time of 81 seconds for a standard color change in the cobalt chloride paper, while the plant in the forest required 285 seconds for a corresponding change. This indicates a tran-

spiration rate *3.5 times as great* in the heath bald at the time the tests were made on these two plants. Each leaf was terminal to a branch bearing about ten leaves located about two feet above the ground. The tests were made between three and four in the afternoon, August 9, 1930, at air temperatures between 73 and 82 degrees F. for the heath bald and 68 and 72 degrees F. for the forest. The two plants were less than 100 feet apart, the forest lying just over the crest of the mountain.

It is interesting to note that the soils of these communities are extremely acid. Between 5,000 and 6,600 feet elevation the reaction of the soil ranges from pH 4.5 to pH 2.8, averaging around pH 3.5. The soils are thin and more or less podsolized and frequently have several inches to a few feet of peat deposited on the surface.

Measurements of the gross dimensions of 100 selected leaves from the two habitats show the influence of the bald habitat to be sufficient to reduce the leaf area from Raunkiaer's *mesophyll* leaf-size class to the next smaller, or *microphyll* leaf-size class. Table I presents the result of the measurements.

Table I. The gross dimensions of leaves of *Rhododenron catawbiense* grown in heath balds and the spruce-fir forest.

	Length in cm.			Width in cm.		
	Mesophytic Forest	Xerophytic Bald	Ratio B/F	Mesophytic Forest	Xerophytic Bald	Ratio B/F
largest dimension	18.5	10.5		7.1	4.3	
smallest dimension	8.1	3.6		3.7	1.5	
average	13.53	6.9	0.51	5.9	2.97	0.50

In addition to a decrease in size of the leaves of plants grown in the heath bald they show other xeromorphic modifications: 1) leaf margins are sometimes revolute, frequently incurled in the case of *Rhododendron catawbiense* until they meet during especially dry times; 2) leaves are likely to be more hairy, scurfy, or densely covered with scales; 3) the color darker; 4) the petioles and branches shorter and stouter.

RESULTS AND DISCUSSION OF ANATOMICAL MEASUREMENTS

Transverse sections of leaf blades were prepared from marginal strips and from mid-vein strips selected about halfway between the apex and the base of the leaves. Thirty-odd sets of measurements of the tissues represented were made independently, half by Mr. Miller and half by my students in ecology. In all measurements the plan of selecting a definite region was followed, e. g., measurements might be made at a place three times the thickness of the leaf in from the margin of the leaf, or in from the mid-vein. This would result in all

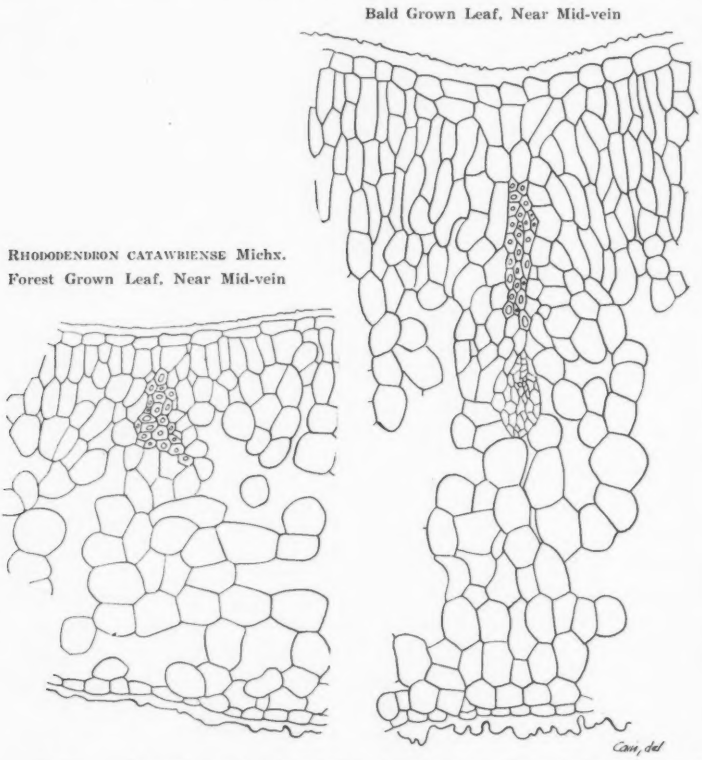

Fig. 4. Camera lucida drawings of typical sections from leaves of plants grown in the heath bald and in the forest.

measurements being made in comparable places on different leaves sufficiently far from the margin and the main vein to avoid abrupt changes in thickness of the leaf or tissues.

Table II presents the average measurements of the tissues for the contrasted habitats. Fig. 4 presents typical sections, drawn by camera lucida. Although the tissues of bald- and forest-grown plants show differences of like order and similar magnitude, so that the ratios are reliable, there are great variations between different leaves from the same plant and the same habitat. It should also be noted that different portions of one leaf show considerable variations. Table III presents the extremes of thickness for different measurements of the same tissue from the same habitat, together with the medians for these ranges. It will be seen that the medians are always higher (thicker) than the corresponding averages.

Table II. *Rhododendron catawbiense.* A comparison of tissues from leaves grown in a heath bald and a spruce-fir forest.

Tissue	No. of samples	Average thickness in microns	Standard deviation $\sigma = \sqrt{\frac{\Sigma D^2}{N}}$	Probable error, a p.e. of a. $= .6745 \frac{\sigma}{\sqrt{N}}$	Ratio B/F	
Upper cuticle						
Bald grown	37	7.4	1.820	± 0.2017	1.37	10x
Forest grown	32	5.4	0.996	± 0.1187		
Upper epidermis						
Bald grown	37	14.3	6.033	± 0.9920	1.30	3x
Forest grown	32	11.0	1.284	± 0.1531		
Palisade						
Bald grown	37	132.8	26.015	± 2.8801	2.21	20x
Forest grown	32	60.1	18.323	± 2.1844		
Sponge parenchyma						
Bald grown	37	251.0	78.915	± 8.7483	1.45	7x
Forest grown	32	173.1	63.887	± 7.4977		
Lower epidermis						
Bald grown	37	13.2	3.144	± 0.3486	1.32	8x
Forest grown	32	10.0	1.537	± 0.1833		
Lower cuticle						
Bald grown	37	5.6	2.884	± 0.3197	2.00	8x
Forest grown	32	2.8	0.957	± 0.1140		
Total blade						
Bald grown	37	431.7	87.8	± 9.7384	1.64	14x
Forest grown	32	263.4	73.6	± 6.9452		

Table III. Extreme and median measurements of tissues of *Rhododendron catawbiense*. Measurements are in microns.

Tissue	Habitat	Leaf-margin Sections Range	Leaf-margin Sections Median	Mid-vein Sections Range	Mid-vein Sections Median
Upper	Bald	5.6 - 7.5	6.5	6.6 - 11.2	8.9
cuticle	Forest	3.7 - 7.5	5.6	4.9 - 7.1	6.0
Upper	Bald	6.9 - 16.9	11.9	9.9 - 38.2*	24.1
epidermis	Forest	7.5 - 13.2	10.3	9.9 - 12.6	11.2
Rows of	Bald	3 - 6	4.5	3 - 6	4.5
palisade	Forest	1 - 2	1.5	2 - 3	2.5
Palisade	Bald	75.0 - 201.3	138.1	90.0 - 198.0	144.0
	Forest	29.7 - 69.3	49.5	42.9 - 96.9	69.9
Sponge	Bald	162.0 - 242.2	207.1	242.0 - 400.5	321.2
parenchyma	Forest	110.8 - 176.2	143.5	177.9 - 328.4	253.1
Lower	Bald	8.2 - 18.7	13.4	9.9 - 22.5	16.2
epidermis	Forest	7.5 - 12.1	9.8	7.8 - 13.2	10.5
Lower	Bald	3.3 - 11.2	7.2	2.2 - 11.2	6.7
cuticle	Forest	1.6 - 4.1	2.8	1.6 - 4.2	2.9
Total	Bald	260.0 - 435.6	347.8	437.3 - 612.0	524.6
blade	Forest	189.6 - 246.0	217.8	301.8 - 415.2	358.5

* Extraordinary thickness due to a single layer of hypodermal cells, appearing like an epidermis two cells thick.

In view of the great variations demonstrated, even from selected leaves, it becomes apparent that significant comparisons must have statistical validity to warrant conclusions as to the effect of environment. The work on the variations of leaf structure in different parts of a leaf, different leaves from the same plant (as to height of insertion, orientation, etc.), and different habitats (sun and shade, etc.) have been adequately summarized by Maximov (1929). Consequently one can have little faith in comparisons which do not consider these possibilities for variation, or which do not consist of a sufficient quantity of duplicate measurements to permit statistical treatment, as in Liebtag and McDougall (1929) and even recently, Whitfield (1933), et. al.

Leaves of bald-green plants showed a development of a hydopermis in the vicinity of the mid-vein. Measured in such places the double layer was 29.2, 38.2, 27.0 and 24.7 microns thick on four leaves, while the single epidermis was only 11.2, 13.5, 15.7, etc. The cuticle was frequently found to be thicker near the margin of the leaf than farther in on the blade. It was sometimes difficult to decide how many rows

of palisade cells a certain leaf had, as one or more of the lower rows would be incomplete or would grade off into typical sponge parenchyma. Such matters produce considerable differences between measurements, but as the probable errors of the averages show, are not sufficient to invalidate the ratios derived from the averages, here based on 32 to 37 measurements for each tissue and each habitat contrasted. If the averages for leaf-margin and mid-vein sections had been kept separate the differences would have appeared greater, so one may use the resultant ratios with entire confidence.

Reference to Table II will show that all the tissues are thicker in those leaves which were grown in the more exposed heath bald habitats. The upper cuticle, upper epidermis and lower epidermis were all about 1.3 times as thick in the bald grown plants as in the forest. The greatest difference was found in the palisade which was over twice as thick in the bald habitat. Palisade cells averaged 34.9 microns in length in the bald grownleaves and 27.1 microns in length in the

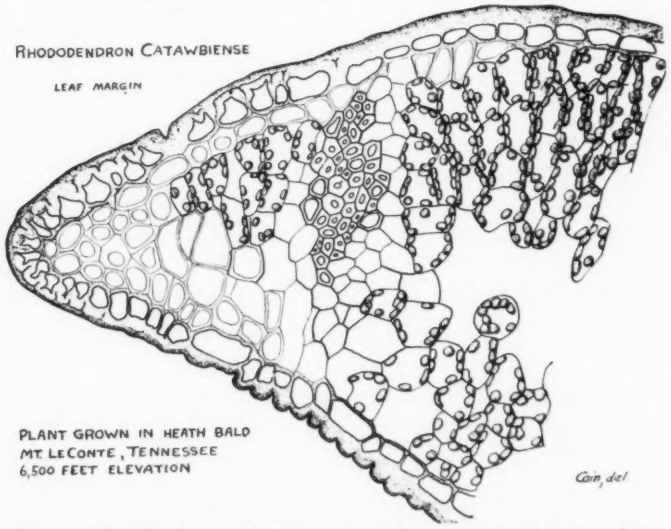

Fig. 5. Detail of a portion from a leaf-margin showing the characteristic appearance of the tissues. Cutinization frequently extends inside of the epidermal cells as here indicated.

forest. The greater palisade thickness in the bald grown leaves is due partly to an increase in length of the cells themselves and partly to the formation of additional rows of palisade cells. In the plants from the heath bald the number of rows of palisade cells varied from three to six with an average at 3.8, or almost twice as many as in the plants from the forest. The sponge parenchyma was about one and one-half times *thicker* in the bald. The ratio of the palisade to the sponge is interesting, being 0.53 for the bald and 0.35 for the forest. In other words, the palisade constitutes about one-half of the mesophyll in the bald grown leaves, but only one-third of the mesophyll of the forest grown leaves. The ratio, palisade-sponge parenchyma, has been shown to vary with parts of a plant and different habitats, being higher in sun forms. Halma (1929) and Langner (1927) indicate that such varieties if hereditary, may be of value in the horticultural selection of citrus, grape, etc. Ecologists will do well to look for the natural selection of such varieties out of the species complex they deal with in the field. In the case of the present species, however, these differences seem to be an expression of the species plasticity, since there is no barrier to prevent the constant intermixing of the population.

Table IV. The proportion of the mid-vein to the leaf blade thickness in *Rhododendron catawbiense*.

Leaves from plants grown in the *heath bald habitat*			
Blade,	average thickness	513.3	microns, 18 samples
" ,	standard deviation	51.3	
" ,	probable error of a	± 8.16	
Mid-vein,	average thickness	1041.0	microns, 18 samples
" ,	standard deviation	167.6	
" ,	probable error of a	± 26.64	
Ratio:	$\frac{\text{mid-vein}}{\text{blade}}$	2.03	
Leaves from plants grown in *spruce-fir forest habitat*			
Blade,	average thickness	354.0	microns, 12 samples
" ,	standard deviation	35.8	
" ,	probable error of a	± 6.97	
Mid-vein,	average thickness	1042.5	microns, 10 samples
" ,	standard deviation	201.2	
" ,	probable error of a	± 42.96	
Ratio:	$\frac{\text{mid-vein}}{\text{blade}}$	2.94	

The last table, Table IV, shows the proportion of the mid-vein to the leaf blade thickness in the two habitats. The mid-veins are remarkably similar in their dimensions, being 1041 microns in the bald and 1042 microns average in the forest. The difference in blade thickness, however, changes the mid-vein blade ratios so that for the bald it is 2.03 and for the forest, 2.94.

There remains one treatment of the data and that is to determine the probable error of the difference of the two results, i. e., the significance of the difference between the average for a tissue grown in the forest and the average from a bald grown leaf.

Babcock and Clausen, in their book, "Genetics in Relation to Agriculture" quote Rietz and Smith in this connection, page 47. "In general, we may take the probable error in a difference to be the square root of the sum of the squares of the probable errors of the two results. If the difference does not exceed two or three times the probable error thus obtained, the difference may reasonably be attributed to random sampling. If the difference between the two results is as much as five to ten times the probable error, the probability of such differences in random sampling is so small that we are justified in saying that the difference is significant. In fact a difference ten times its probable error is certainly significant in so far as there is certainty in human affairs."

The difference between forest grown and bald grown tissues is from three to twenty times the probable error of the difference as described above. See, last column of Table II. The only difference to lack statistical significance is the upper epidermis for which the difference is three times the probable error of the difference. The differences for the rest of the tissues are as follows: upper cuticle, ten times the probable error; palisade, twenty times; sponge parenchyma, seven times; lower epidermis, eight times; lower cuticle, eight times; total blade, fourteen times.

It is of interest to call attention to a paper by Lippmaa (1929) in which the ecological anatomy of a number of plants is considered in respect to the habitat and the plant communities in which they grow. In considering the light

question, in respect to Norwegian and Finnish Lappland, Lippmaa studied the anatomy of 73 different species, giving, in one table, the comparative measurements of the total blade thickness, the height of the palisade, the thickness of the outer epidermal wall, and the stomatal frequency for the upper and the under epidermis of the leaf blade. These species represent three formations (not in the sense of Amrican ecologists); the dwarf shrub heath, with 20 species; the meadow

Table, condensed from Lippmaa, 1929.

The species	The formations	The regions	Thickness of the leaf blade in microns	Height of palisade layer in microns	Thickness of outer wall of upper epidermial cells in microns	No. stomata per sq. mm., upper surface	No. stomata per sq. mm., lower surface
Cornus suecica	(heath)	Kt.	180	60	2.5	0	117
Cornus suecica	(woodland)	Pp.	110	30	1.4	0	65
Vaccinium myrtillus	(heath)	Kl.	160	45– 90	3.0	110	236
Vaccinium myrtillus	(woodland)	Kl.	135	45	2.2	44	142
Vaccinium vitis idaea	(heath)	Kl.	410	60–200	7.0	0	497
Vaccinium vitis idaea	(woodland)	Kl.	300–350	39– 90	6.0	0	280
Linnaea borealis	(heath)	Kl.	230	30– 60	3.0	0	457
Linnaea borealis	(woodland)	Kl.	200	30	3.0	0	225
Aspidium dryopteris	(heath)	Pp.	180	—	1.0	0	50
Aspidium dryopteris	(woodland)	Pp.	140	—	1.0	0	24

The regions: Kt, Kolttakongas region; Pp, Paaskyspahta region; Kl, Kilpisjarvi region.

The formations: (Heath), the dwarf-shrub heath; (woodland), the meadow-birch woodland.

plants (Wiesenbirkenwälder, Hochstaudenwiesen and Wiesen) with 34 species; the snow meadows, with 24 species. The "Wiesenbirkenwälder" are woodland types with meadow plants forming the ground cover. Five species, which are common to the dwarf-shrub heath and the meadow-birch woods, are given in the accompanying table, since contrast of their anatomical structures is of special interest to our own studies, which compare the differences exhibited by a single species growing in two communities.

From a consideration of the table, which was made up from data provided by Lippmaa's larger table, it is apparent that in all cases where there are comparative data for the heath and for woodland types the heath-grown plants have thicker leaf measurements and more numerous stomata per sq. mm.

Lippmaa emphasizes that for all species of the heath the leaf blade is proportionally reduced as to surface, especially for the evergreen species, some of which endure as long as 5 to 10 years or more; the outer wall of the epidermis is thick, the palisade well-developed, the stomata are limited to the lower surface, with only two exceptions, the number of stomata per squ. mm. is not surprisingly large, while in those which do have a high stomatal frequency the reduction in surface compensates for it (the number is relatively greater in the heath, however). He suggests that the relatively high number may be referred back to their phylogenetic development for a common reason. The mark of the habitat is found, furthermore, in the more nearly vertical orientation of the shoots and leaves on the shoots, and in the general dwarfing of the growth.

SUMMARY AND CONCLUSIONS

1) The leaves from the plants of *Rhododendron catawbiense* grown in the more exposed heath bald habitat show:

a) reduction from mesophyll leaf-size class (in the forest) to microphyll leaf-size class;

b) greater leaf curling, scurfiness, denser chlorophyll, and shorter and stouter petioles;

c) increase in thickness of all blade tissues and cuticle,

increase of the number and length of palisade cells, of the palisade/sponge ratio;

d) wider range of variation between extremely thick and extremely thin tissues;

e) decreased mid-vein/blade ratio;

f) a hypodermis, especially on the upper side in the vicinity of veins.

2) In view of the wide variations among measurements of different sections of the same leaf, different leaves of the same plant, and different plants from the same habitat, it seems imperative that contrasts of ecological anatomy of the same species grown in different habitats must have statistical validity. The least which can be done is to select for study comparable material, from all these viewpoints, or better, handle a quantity of sections to give reliable averages.

INDIANA UNIVERSITY.

BIBLIOGRAPHY

1) *Cain, Stanley A.* 1930. An ecological study of the heath balds of the Great Smoky mountains. Butler Univ. Bot. Studies, 1: 177-208.

2) ———————— 1931. Ecological studies of the vegetation of the Great Smoky Mountains of North Carolina and Tennessee. I. Soil reaction and plant distribution. Bot. Gaz. 91: 22-41.

3) *Davis, John H. Jr.* 1930. Vegetation of the Black Mountains of North Carolina: an ecological study. Jour. Elisha Mitchell Sci. Soc. 45 (2): 291-318.

4) *Halma, F. F.* 1929. Quantitative differences in palisade tissue in certain citrus leaves. Bot. Gaz. 87: 319-324.

5) *Langner, W.* 1927. Uber die Verteilung der Stärke in Laublättern zu verschiedenen Tageszeiten. Jahrb. Wiss. Bot. 67: 291-333.

6) *Liebtag, C. E.* and *W. B. McDougall.* 1929. Ecological foliar anatomy of some plants common to Illinois and North Carolina. Trans. Illinois State Acad. Sci. 21: 77-83.

7) *Whitfield, C. J.* 1933. The ecology of the Pike's Peak region. Ecol. Monographs 3(1): 75-105.

8) *Lippmaa, Theodor.* 1929. Pflanzenökologische Untersuchungen aus Norwegisch — und Finnisch — Lappland unter besonderer Berücksichtigung der Lichtfrage. Acta Instituti et Horti Botanici Univ. Tartuensis (Dorpatensis) 2(1-2) : 1-165.

ECOLOGICAL COMPARISON OF LEAF STRUCTURES OF RHODODENDRON PUNCTATUM ANDR.

And the ontogony of the epidermal scales

WILBUR H. DUNCAN

Rhododendron punctatum Andr. [figure 1] is a low branching shrub, one-half to two meters tall, with resin-dotted foliage. These dots are scales that are mainly on the lower leaf surface but are also on the upper surface and the petioles. They are also apparent on young twigs. The shrub grows in various places on the mountain top and the upper slopes, and the external appearances vary somewhat with the habitat. Comparing two types, one from a bald and another from a spruce-fir forest, we notice changes in xeromorphic character. The leaf margins are more revolute, the color darker, the sur-

Fig. 1. *Rhododendron punctatum* Andr. as it appears growing at the margin of a heath bald. Photograph by the courtesy of Jim Thompson Co., Knoxville.

faces generally more scurfy, and the leaves dwarfed. There are often more epidermal hairs near the midvein on the leaves from the bald.

Measurements of one hundred leaves from the two habitats (Cain 1930), give convincing evidence of the dwarfing of the leaves (Table I). The leaves from the mesophytic spruce-fir forest averaged 8.21 cm. in length and those from the bald only 4.20 cm., smaller in size by almost one-half. In the former the width averaged 2.81 cm. and in the latter 1.80 cm., a difference of one-third of the former.

Some specimens of leaves of *Rhododendron punctatum* collected in the Great Smoky Mountains included a number from each of two habitats, a spruce-fir forest and a nearby bald. Sections of leaves were prepared with the idea of making comparative measurements. In order to eliminate, as far as possible, any difference due to variations in the leaf itself, measurements were made at certain definite places on sections that were chosen from the same areas of the leaves.

Measurements were made of the leaf blades somewhere between 1.5 and 2 mm. from the middle of the vein, and at places the least covered and consequently the least protected by the scales. They were made at such places between the scales as are indicated in the camera lucida drawings [figures 2 and 3] of the general outline of the leaves from the two habitats. At 1.5 mm. from the midvein the leaf was free from enlargement due to the vein.

TABLE I.

Comparison of leaf sizes (blades) of *Rhododendron punctatum* grown in heath balds and under protection of forest. (Each measurement is based on 50 representative leaves.)

All measurements in cm.	Largest	Smallest	Average dimension	Ratio B/F
Length				
Woodland	11.2	4.0	8.21	1.96
Bald	6.9	2.5	4.20	
Width				
Woodland	3.9	3.3	2.81	1.56
Bald	1.2	1.0	1.80	

Another set was made 1 mm. from the leaf margin but on different leaves. The measurements of both sets were averaged, and the standard deviations and probable errors of the mean were calculated.

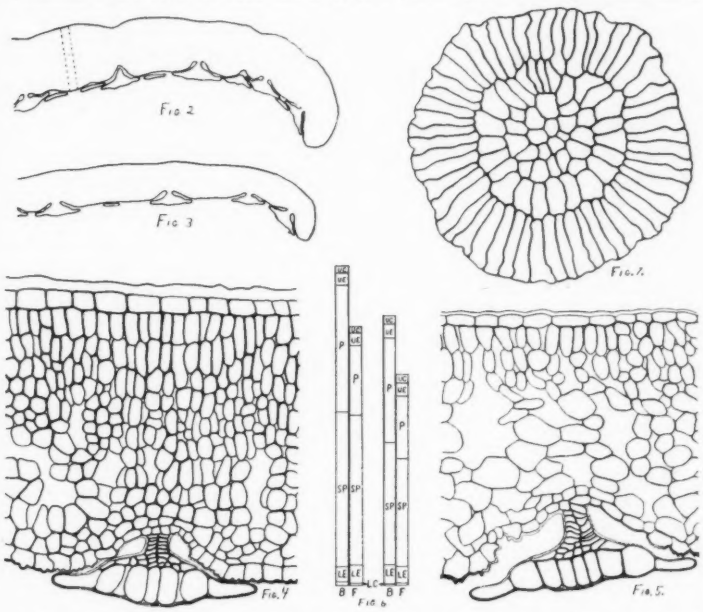

Fig. 2. Camera lucida drawing of outline of a cross section prepared from a leaf taken from a heath bald habitat. Dotted line indicates region measured.

Fig. 3. Outline of leaf taken from a spruce-fir forest habitat.

Fig. 4. Camera lucida drawing of a cross section of a leaf taken from a heath bald community.

Fig. 5. Cross section drawing of leaf from a spruce-fir forest. On same scale as figure 4.

Fig. 6. Diagramatic representation of the average measurements of lower cuticle (LC), lower epidermis (LE), sponge parenchyma (SP), palisade (P), upper epidermis (UE), and upper cuticle (UC) in the leaves from the bald (B) and forest (F). The midvein averages are diagramed on the left, and the leaf-margin on the right.

Fig. 7. Surface view of an epidermal scale.

The standard deviation (σ) is equal to the square root of the summation (Σ) of the deviations from the average squared (d^2) and divided by the number of variates (n). The probable error of the mean (Em) is found by multiplying 0.6745 times σ and dividing by the square root of n. It may be said that there is an equal chance that the true value lies within the positive and negative limits of the probable error.

Measurements of the midvein sections are given in Table II. The total blade was about one-fourth thicker in the bald grown leaf, largely due to an increase in palisade tissue. The drawings (figures 4 and 5) show sections of typical leaves from the two habitats. The diagramatic representation of the

TABLE II.

Table of average midvein measurements of ten leaves from bald and ten leaves from forest.

Tissue	Mean average microns	Standard deviation	Probable errror	Ratio B/F	D / p.e. of D
Upper cuticle					
Bald	7.67	1.16	0.25		
Forest	6.53	0.90	0.19	1.17	3.6
Upper epidermis					
Bald	11.51	1.27	0.27		
Forest	11.90	1.37	0.29	.97	0.9
Palisade					
Bald	121.97	15.36	3.28		
Forest	66.33	8.36	1.78	1.84	14.5
Spongy parenchyma					
Bald	148.58	19.45	4.15		
Forest	142.89	13.35	2.85	1.04	1.1
Lower epidermis					
Bald	14.18	0.74	0.16		
Forest	17.33	0.98	0.21	.82	12.0
Lower cuticle					
Bald	3.20	0.63	0.16		
Forest	1.49	0.56	0.12	2.15	8.5
Total blade					
Bald	306.61	24.65	5.26		
Forest	246.47	19.22	4.09	1.25	9.0

average tissue sizes (figure 6) gives again the idea of the differences in the leaves.

In the palisade tissues of the bald grown plants there averaged twice as many rows of palisade cells as in the forest grown leaves. The least thickness encountered in the former was greater than the greatest found in the latter. The cuticle on both surfaces of the leaf was more developed in the xerophytic form. The upper epidermis and the spongy tissues averaged nearly the same thickness; at least not enough difference was found, to be sifnificant with only the averages of ten leaves, as the probable error of the mean indicates. The

TABLE III.

Table of average midvein measurements of ten leaves from bald and ten leaves from forest.

Tissue	Mean average microns	Standard deviation	Probable errror	Ratio B/F	D / p.e. of D
Upper cuticle					
Bald	7.35	1.52	0.32		
Forest	6.48	0.89	0.19	1.12	2.5
Upper epidermis					
Bald	13.74	0.96	0.21		
Forest	12.86	1.11	0.24	1.07	2.8
Palisade					
Bald	98.44	9.24	1.97		
Forest	59.85	9.32	1.98	1.64	14.0
Spongy parenchyma					
Bald	115.68	8.77	1.87		
Forest	102.55	14.10	3.01	1.13	3.8
Lower epidermis					
Bald	17.24	1.24	0.26		
Forest	15.23	1.66	0.25	1.13	5.5
Lower cuticle					
Bald	1.75	.....	.....		
Forest	1.58	.....	.....	1.11	.....
Total blade					
Bald	254.20	14.12	3.00		
Forest	198.50	19.44	4.15	1.28	11.0

lower epidermis of the bald leaf was thinner than that of the forest.

Examining the measurements (Table III) we find that the thicknesses of total blade were one-fourth smaller at the margin, and all tissue measurements except the upper and lower epidermis of the bald and the upper epidermis and lower cuticle of the forest leaves were smaller than those made near the midvein. However, the lower cuticular thicknesses were so small and difficult to measure that they could easily have been in error. These differences indicate that comparative sections for measurement of tissues should always be made in comparable places on the leaf.

Comparing the tissues of the leaves from the two habitats we find that in every case they were thicker in the bald. The bald/forest ratios vary from 1.07 in the upper epidermis to 1.64 in the palisade. The other ratios are as follows: lower cuticle, 1.11; upper cuticle, 1.12; lower epidermis and spongy parenchyma, 1.13; and the total blade, 1.28.

Since the palisade tissues vary considerably, it would be well to look at further relationships (Table IV). It is noted that the palisade/sponge ratio, and the per cent which the palisade is of total mesophyll, were larger in the leaves from the bald. According to Hanson (1917) the palisade tissue in leaves from the sunny part of a tree constituted a greater percentage of the total leaf thickness than in leaves from the shaded part.

TABLE IV.

Table of palisade relationships of leaves from bald and forest.

Sections	Habitat	Percent of the total mesophyll	Length of cells per row in microns	Ratio palisade / sponge
Midvein	Bald	45.1	24.77	.82
	Forest	31.3	26.25	.46
Leaf-margin	Bald	45.9	21.17	.85
	Forest	36.8	23.94	.58

Other xeromorphic characteristics of leaves have been cited by numerous workers. Zalenski, according to Maximov (1929), indicates that all kinds of mesophyll cells have smaller dimensions under xerophytic conditions. Due to the less turgid condition of the cells of young leaves in the xerophytic habitat at the time of leaf formation, all cells would be smaller. The average length per row of all the palisade cells was found to be smaller in the bald than in the forest grown leaf by about two microns, which would indicate that the increase was in no way due to elongation. However, another set of measurements was made (Table V). On the leaf margin sections, approximately three mm. from the margin, measurements of the first row of palisade were made. Averaging the heights of thirty palisade cells from each of the ten leaves, the first row of palisade tissue in the bald was found to be thicker by at least five microns above the p. e. At least as far as these measurements go, palisade thickness is augmented by palisade cell elongation in some rows, at least the first. This might be due to the stronger effect of the light on the first rows, which is generally correlated with elongation of palisade cells.

Clements (1904) found that the veins were closer together in sun leaves than in shade leaves, which is generally considered a character of xeromorphic leaves. There was an apparent difference in vascular structures of the leaf. Average distances between veins of the reticulum were determined. The results (Table VI) showed a closer net work of the veins, the bald/forest ratio being .61 in the leaf margin sections and .82 in the midvein sections.

TABLE V.

Table showing the average heights of thirty palisade cells in the first row from each ten leaves from the forest and ten from the bald.

Habitat	Mean average microns	Standard deviation	Probable error	Ratio B/F
Bald	28.37	1.30	0.28	1.24
Forest	22.86	1.16	0.22	

The diameters of seventy scales from each of four leaves, two from the forest and two from the bald, were measured and the averages computed. The scales were scraped from the under surface of the leaves with a scalpel and mounted in glycerin, and in that condition were easily measured. The upper surface of one of the scales is shown in figure 7. A little smaller diameter is shown in scales from the bald leaf (Table VII), but in leaves from the same shrub there would possibly be as much variation as is shown between any of the four measured.

It has been suggested by Wiegand (1910) that cutin or resinous coverings are much less efficient retarders of evapo-

TABLE VI.

Table of average distances between veins and scales in ten leaves from bald and ten from forest habitats.

(Distances are in microns)

		Mean average	Standard deviation	Probable error	Ratio B/F	D / p.e. of D
Veins						
Leaf-margin	Bald	234.01	29.08	6.20		
sections	Forest	383.51	92.97	19.81	.61	7.3
Midvein	Bald	255.63	39.15	8.34		
sections	Forest	310.41	32.72	6.97	.82	6.0
Scales						
Leaf-margin	Bald	234.74	33.64	7.24		
sections	Forest	307.29	32.00	6.83	.76	7.3
Midvein	Bald	308.32	34.65	7.38		
sections	Forest	378.58	63.24	13.48	.81	4.5

TABLE VII.

Table of measurements in microns showing the average diameters of seventy scales from each of four leaves.

Leaf no.	Habitat	Mean average	Average diameter for habitat	Ratio B/F
1.	Bald	247.24	250.41	.98
2.	Bald	253.58		
3.	Forest	257.05	255.48	
4.	Forest	253.90		

ration in the wind than hairy coverings. Thus, with wind action much more effective in the bald we might expect thicker and better development of scales. As was mentioned previously the leaves in the bald habitat were more scurfy. In the general outlines (figures 2 and 3) there is indicated the closer proximity of the scales that cause this scurfy appearance. The comparative distances between the scales is afforded by the set of measurements whose averages are shown in Table VI. The bald/forest ratio of the distances between the scales was .81 near the midvein and .76 near the margin. The frequencies are likely only relative. Salisbury (1927) found that higher stomatal frequencies (i. e. more stomata per unit area) were due to differences in the size of the cells (i. e. to the spacing of the stomata), rather than to differences in the ratio of number of stomata to number of epidermal cells, which he introduced as the concept of stomatal index. This is given by the formula $I = S \times 100/(E + S)$, where I is the stomatal index, S the number of stomata per unit area, and E the number of epidermal cells in the same unit area. Comparing the ratios of bald to forest in the leaf sizes we find that the leaf itself diminishes sufficiently in size to more than account for the difference in scale frequency. There is very little reason to suppose that the frequency of the scales is other than largely relative. Farther investigations in the future are needed to establish the relations that actually exist.

It is interesting to note that both the veins and scales are closer together near the leaf margin again warning against random selection of sections for measurements.

The consideration of the probable error of the differences of results in measurements of random sampling is described in Dr. Cain's paper on *Rhododendron catawbiense* in this number. Examining the results of such calculations which are included in Tables II, III, and VI, we find that the differences between the two results vary from .9 to 14.5 times the probable error of the difference. The differences in upper epidermis and spongy parenchyma in the midvein measurements and the upper epidermis and cuticle in the leaf margin are the only ones lacking statistical significance, i. e., less than three times the probable error of the difference between means.

Kratzmann, as quoted by Braun-Blanquet in Hegi's "Illustrierte Flora von Mittel-Europa," describes the origin of the shield hairs on Rhododendron species of the Mediterranean region. They arise from an epidermal cell, and in young condition have the appearance of glandular hairs with a multicellular stem, and it might be assumed that shield hairs are formed through differentiation of secreting hairs. Tests have shown that secretions were present in them. Cooper (1932) describes a peltate hair as consisting of a central stalk bearing a flattened conical shield made up of a considerable number of ray cells which usually have somewhat thickened walls and empty cavities. The distal end of each of these ray cells is free and tapers to a point. Prillieux, according to Cooper (1932), considered the peltate hair to be actually a stellate hair in which the radiating cells of the shield are held together by a cuticle.

Transverse sections of a terminal bud were carefully prepared. Scales in various degrees of development were present on the leaves in the section. Examination of the development of the scales indicates structures different from the peltate

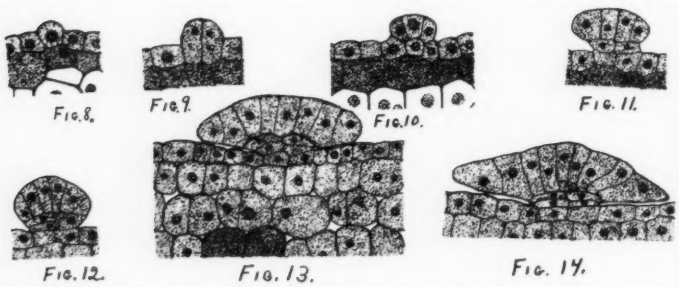

Fig. 8. Part of a leaf from a bud showing one-celled stage in the development of a scale.

Fig. 9. Two-celled stage.

Fig. 10. Six-celled stage showing three of four shield cells and one of the two stalk cells.

Fig. 11. Sixteen-celled stage.

Figs. 12, 13 and 14. Further successive stages in the scale development.

hairs as described by Cooper and by Prillieux. In young stages they are very similar to glandular hairs.

The first indication of the formation of a scale is the enlargement of the cell from which it is to develop (figure 8). The cell soon divides in a plane perpendicular to the surface of the epidermis (figure 9). Then both cells elongate above the epidermis and divide parallel to the surface, the shield developing from the outer cells, the stalk from the inner cells. The two cells now present above the epidermis divide vertically forming a four-celled shield (figure 10). The formation of a four-celled stalk then occurs by similar divisions and then eight cells by horizontal divisions. Previous to the latter division the shield had become eight-celled, the whole appearing in cross section as in figure 11. These divisions are vertical as are all the remainder of the divisions of the shield.

Further development of the stalk occurs largely by divisions of the four cells next to the shield (figures 12, 13, and 14). Enlargement of the shield itself is mostly radial occuring by division and elongation of the cells, especially those near the edge. It is near the stages represented in figures 11 and 14, that the scale appears so much like a glandular hair.

The scale shown in figure 14 is little over one-third of the mature size. When full size is attained the cell walls thicken and the protoplasmic contents disintegrate. The pit covered by the scale (figures 2, 3, 4, and 5) is possibly formed by physical action of the compact bud. Most of the stomata are in this pit under the scale and the dead air space undoubtedly retards transpiration. There is a possibility that the scales act as water absorbers during wet periods, as in the case of Tillandsia, as described in Coulter, Barnes, and Cowles, Fuller (1931). Capillarity would easily draw the water back under the scale. However, water would by necessity, enter through the thin epidermal cells adjacent to the stalk, rather than through the well cutinized stalk. It is hoped that physiological and transplant studies in the future will show clearly the relations of the xeromorphic leaf and scale structures to the processes vital to the plant.

SUMMARY AND CONCLUSIONS

1) In contrasting the tissues of leaves of *Rhododendron punctatum* plants grown in spruce-fir forest and in heath bald habitats, the following tissues of the bald grown leaves were found to be thicker: *midvein sections;* upper cuticle, palisade, sponge parenchyma, lower cuticle; *leaf-margin sections,* all tissues. The thickness of the total blades were correspondingly larger in the bald grown leaf.

2) Palisade relationships:

a) There were approximately twice as many rows of palisade cells in the bald grown leaves.

b) The thicknesses of the palisade tissues were four-fifths more in the bald grown leaves in the midvein measurements, and three-fifths more in the leaf margin measurements.

c) The average length of the palisade cells per row (all rows) in the bald grown leaves was approximately two microns less than in the leaves from the other habitat. However the average length of the first row of palisade cells in the former was about five microns more than in the latter. Further investigations are needed to establish what relationship the light factor might have in this regard.

d) In the midvein and leaf margin sections the palisade/sponge ratio was .82 and .85, respectively, in the leaves from the bald, and .46 and .58 in the forest grown leaves. The percentage of total mesophyll was larger in the bald grown leaves.

3) The xeromorphic character of the bald grown leaves was indicated by the closer network of veins. The epidermal scales were closer in the xeromorphic leaf, but probably only relatively more numerous.

4) From the probable error of the difference between averages of contrasted tissues (i. e. heath bald and forest grown) we find a range from .9-14.5. Only the differences in

the following tissues (being less than three times the probable error of the difference) were without statistical significance: *midvein sections*, upper epidermis and spongy parenchyma; *leaf-margin sections*, upper cuticle and upper epidermis.

5) The development of the scales from epidermal cells was studied, and it was found that they developed entirely from the epidermis proper. There is a possibility that the scales act as water absorbers but further studies are necessary to establish the exact relationships.

6) Finally, it may be said that *Rhododendron punctatum*, as a plastic species, offers a wide and interesting study in relation to environmental conditions. Physiological and transplant studies in the future will probably establish for certainty many relations that were only suggested in the past.

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BIBLIOGRAPHY

Braun-Blanquet, J. Ericaceae (= Vacciniaceae) in *Hegi, G.* Illustrierte Flora von Mittel-Europa, V. Band, 3. Teil, s. 1629.

Cain, S. A., 1930. An Ecological Study of the Heath Balds of the Great Smoky Mountains. Butler U. Bot. Studies I: 177-208, 1930.

Clements, 1904. The Relation of Leaf-Structure to Physical Factors. Amer. Mic. Soc. Trans., 25 and 26: 19-102, 1903-4.

Cooper, D. C. 1932. The Development of the Peltare Hairs of *Shepherdia canadensis*. Amer. Jour. Bot. 19: 423-428, 1932.

Fuller, G. D. in *Coulter, Barnes, & Cowles*, 1931. A Textbook of Botany, Vol. III, Ecology: 123-124, 1931. American Book Company, N. Y.

Hanson, H. C. 1917. Leaf-Structure as Related to Environment. Amer. Jour. Bot. 4: 533-560, 1917.

Maximov, N. A. 1929. The Plant in Relation to Water (Edited by R. H. Yapp). Pages 325-373. George Allen & Unwin. London.

Salisbury, E. J. 1927. On the Causes and Ecological Significance of Stomatal Frequency, with Special Reference to the Woodland Flora. Phil. Trans. Roy. Soc. London, 216B, 1-65, 1927-28.

Wiegand, K. M. 1910. The Relation of Hairy and Cutinized Coverings to Transpiration. Bot. Gaz. 49: 430-444, 1910.

A COMPARISON OF LEAF TISSUES OF GAYLUSSACIA BACCATA (WANG.) C. KOCH. AND VACCINIUM VACILLANS KALM.

Grown under different conditions.

STANLEY A. CAIN AND JOHN E. POTZGER

The investigations reported in this paper are concerned primarily with the comparative thickness of leaf tissues of two species of Ericaceae grown under different conditions. These species are characteristic of poor, acid, hill-top soils in southern Indiana. In the field they showed some plasticity as to sun and shade forms and were consequently considered good material for a study of the possible effect of the evaporating power of the air on tissue proportions.

Early in the spring of 1929 before the buds had started to swell several transplants of these species were made to the Butler University greenhouse. The plants were dug up with a sufficiently large ball of earth to avoid disturbance of the root system and placed in wooden buckets of about fifteen inches in diameter in which they were left throughout the season. Two buckets of each species were placed into one small greenhouse room and a twelve-inch electric fan was allowed to blow across the plants without interruption from May until October. In the tables and the remainder of the discussion this condition is designated as the fan room. Similar plants were placed into another greenhouse room but were exposed only to the normal greenhouse conditions. These transplants were all watered as frequently as necessary and wilting did not occur throughout the season. Temperature and light conditions were essentially uniform in the two houses. For further comparisons plants in the native habitat were also studied. For a description of the Sycamore Creek region, Morgan County, Indiana, from which the transplants were taken see papers by Cain and Friesner.[1]

[1] Butler Univ. Botanical Studies 1: 1-28. 1929.

Records of the evaporating power of the air were made by weekly periods for each of the three situations, the fan room, the greenhouse and the field.[2] Livingston spherical atmometers were used and the losses reduced to standard amounts. Ratios for the two greenhouse conditions were expressed on a basis of the field condition as unity. Table (I).

Table I. Standard average losses from atmometers by weekly periods from the different conditions, and ratios based on the field condition.

Station	Date 1929	Average weekly loss in cc.	Ratio
Field station Morgan Co.	5-22 to 6-27	121	1.00
Greenhouse, normal	5-22 to 6-26	135	1.12
Fan room of greenhouse	5-22 to 6-26	377	3.12
Field station Morgan Co.	6-27 to 9-21	102	1.00
Greenhouse, normal	6-26 to 9-27	159	1.56
Fan room of greenhouse	6-26 to 9-27	407	4.00

Leaf material was collected and preserved at two periods during the season. The first collection was made on the twenty-sixth of June and the second collection was made on the second of October. The evaporation in the fan room was roughly three times that in the normal greenhouse room and that in the field for the period preceding the June collection of leaves. For the balance of the season the rate of water loss by the atmometer in the fan room was four times that in the field and about two and a half times that in the normal greenhouse. The evaporation from the atmometer in the fan room was about 400 cc. per week which is greatly in excess of average losses which the species encounter in their native habitat. It is to be remembered, however, that these plants

[2] The authors wish to thank Prof. Ray C. Friesner for the use of the greenhouse space and assistance in getting the evaporation data during the summer period.

always had an adequate supply of soil moisture, which was not true of the plants grown in the field.

For each of the conditions ten leaves that seemed to represent average development were selected from the plants. Strips were cut from the leaves, about half way between the apex and the base of the blade, in the midvein region and from the margin. These strips were later imbedded, sectioned and stained. The measurements on which the means, given in the tables, were based were made in comparable places, i. e. on the blade a proportionate distance from the midvein, or from the margin.[3]

RESULTS

Gaylussacia baccata

The average thickness of the six regions of the leaf which were measured and of the total blade is given in Table (II). This table permits a ready contrast of the midvein and leaf margin regions of the species grown (in) under the three conditions, together with the probable error of each mean. The probable errors (p. e.) were figured according to the following formula.

$$\text{p.e.} = 0.6745 \times \frac{\sigma}{\sqrt{n}}$$

The standard deviation (σ) not given in the tables, was figured by the following formula:

$$\sigma = \sqrt{\frac{\Sigma D^2}{n\text{-}1}}$$

n-1 being more accurate for as small a number of variants as ten.

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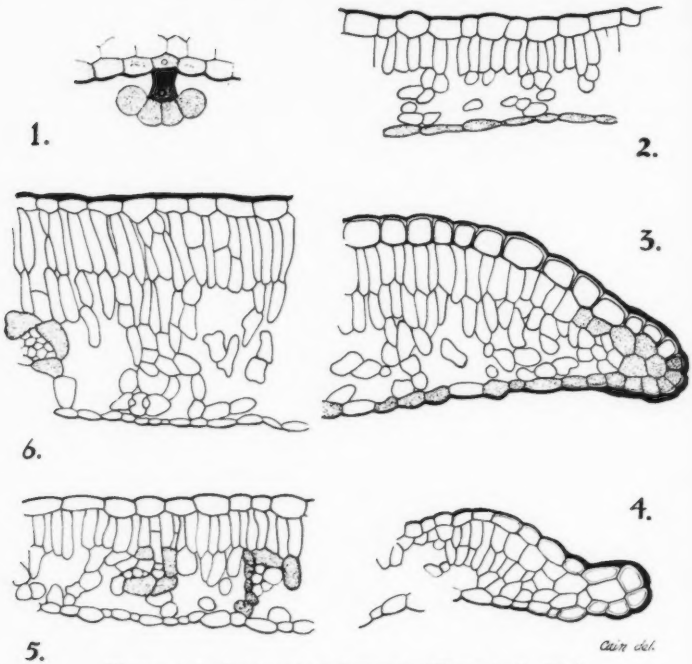
[3] In some collections the averages are based on less than ten leaves each, as shown in the tables. This was due to misplaced material during the three year period which elapsed between the date of collection and the date of preparation of the slides.



Figues 1-3, *Gaylussacia baccata* (Wang.) C. Koch.

Fig. 1, glandular hair; they are infrequent on the lower side of leaves. This scale is twice that of the size of the remaining figures. *Fig. 2*, transverse section from midvein region of leaf from plant grown in the fan room. Leaf No. 1-7 collected 6-26-29. *Fig. 3*, transverse section of the margin of a leaf grown in field conditions. Leaf No. 6-4 collected 6-27-29. Note the heavy cutinization, especially at the leaf margin. The stippled cells are filled with a dark-staining material, probably of a fatty nature.

Figures 4-6, *Vaccinium vacillans* Kalm.

Fig. 4, leaf margin section showing the heavy cutin and tendency to curl. *Fig. 5*, same section as figure four but in a typical portion of the blade. Leaf No. 18-10 from a plant grown under normal greenhouse conditions. Collected 10-2-29. *Fig. 6*, typical portion of leaf blade from the marginal region. Leaf No. 12-2 from a plant grown under field conditions. Collected 6-27-29. Throughout this species there is a tendency for dark-staining materials to accumulate in cells surrounding the small veins.

Table II. Comparison of tissues of *Gaylussacia baccata* leaves from plants grown under different conditions. Collected 6-26-29.

Tissue		Fan room of greenhouse; evaporation ratio, 3.12		Normal greenhouse; evaporation ratio, 1.12		Characteristic field habitat; evaporation ratio, 1.00	
		N	Mean and p.e.	N	Mean and p.e.	N	Mean and p.e.
Upper cuticle	MV	10	2.38 ± .14	2	2.55 ± .0	10	1.10 ± .09
	M	10	1.61 ± .18	10	1.44 ± .12	8	2.13 ± .35
Upper epidermis	MV	10	17.68 ± .59	2	17.80 ± .57	10	27.70 ± .76
	M	10	16.6 ± .836	10	19.38 ± .57	8	27.6 ± 1.12
Palisade	MV	10	35.7 ± 1.79	2	31.4 ± 4.01	10	47.8 ± 3.44
	M	10	36.0 ± 1.20	10	31.6 ± 1.08	8	75.0 ± 6.40
Sponge parenchyma	MV	10	44.37 ± 2.21	2	56.1 ± 1.15	10	77.0 ± 2.75
	M	10	40.3 ± 3.34	10	45.4 ± 2.19	8	53.1 ± 3.23
Lower epidermis	MV	10	14.7 ± .55	2	15.3 ± 2.29	10	19.3 ± 1.01
	M	10	13.8 ± .71	10	12.3 ± .52	8	16.1 ± .73
Lower cuticle	MV	10	1.7 ± .13	2	1.3 ± .41	10	1.1 ± .13
	M	10	1.19 ± .09	10	1.02 ± .08	8	1.06 ± .09
Total blade	MV	10	116.4 ± 3.05	2	123.1 ± 6.88	10	173.8 ± 2.24
	M	10	109.2 ± 3.29	10	111.2 ± 2.34	8	177.0 ± 4.39

N equals the number of leaves used to obtain the mean.
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.
The means are given in microns for the thickness of each tissue.

In the first place it may be noted that the tissues and the total blades are usually thicker in the midvein region, but this is not without exceptions and the differences are never very great. The only case where the difference between means for the midvein and the margin is significant is in the palisade and the sponge of leaves from plants grown under field condi-

tions. Here the palisade of the leaf margin is thicker by 27 microns at a statistical value (V) of about four times. (See the explanation below.) In the same set of leaves the thickness of the sponge parenchyma is greater in the midvein region by a value of about five times. Under both greenhouse conditions these mesophyll tisues are remarkably similar in both the leaf regions. An explanation of this effect of the field conditions does not occur to us at the present time.

A comparison of the tissues of leaves from the different growing conditions can best be made on a basis of the probable error of the difference. This value (V) of the difference can be determined by the following formula:

$$V = \frac{D}{\sqrt{p.e.m^2 + p.e.M^2}}$$

If the value of V is three or less the difference (D) between the two averages (m and M) is probably not significant. If the value is six to ten or more there is very slight probability that the difference could occur from random sampling. Table III contrasts the tissues and total blade thickness of the species grown under the three conditions. It is apparent that the two greenhouse conditions did not induce differences of any statistical significance between them, but the field grown plants were significantly different from the greenhouse grown plants, being generally thicker.

In the field habitat the plants developed a very much heavier upper epidermis, especially in the midvein region. The palisade was thicker, and significantly so, from the leaf margin sections. On the other hand, the sponge parenchyma was significantly thicker in the midvein region. The cuticle and the lower epidermis tend to be highly variable. The total blades were significantly thicker throughout.

When the means for tissues of leaves from plants grown in the normal greenhouse room and in the fan room are compared there seem to be no difference which exceeds the probable error of random sampling. This would indeed seem

strange, considering the great difference in evaporating power of the air, and the matter is discussed in a later paragraph.

An examination of the number of rows of palisade cells is interesting. The greenhouse grown plants consistently had a single row of palisade cells while the field leaves frequently showed a second partial row. This was probably due to light quality since not one of the plants was shaded except by its neighbors. The palisade/sponge parenchyma ratio, which is usually considered one of the important aspects of comparative leaf anatomy from the ecological point of view, varied in the three habitats as follows: 1) plants from the fan room, p/s for the midvein region equals .80, for the margin region .89; 2) plants from the normal greenhouse, p/s for the midvein region equals .56, for the margin .68; 3) plants from the field, p/s for the midvein region .62, for the margin 1.41. These ratios average as follows: fanroom .85, greenhouse .62, and field 1.01. The palisade is proportionately thicker in the field grown plants than in the greenhouse grown plants. Between the two greenhouse situations the one with the high rate of evaporation produced plants with thicker palisade (p/s ratio).

About three months after the June collections of leaf material, October second, duplicate material was collected from the greenhouse grown plants. The results are given in Table (IV). The progress of the season under the strong evaporation difference did not affect any significant differences between the tissues of the leaves from the fan room and from the normal greenhouse. In comparing the averages from the June collections with the averages from the October collections it is found that every tissue had become thicker as the season progressed. Table (V). This was not consistently true of the plants in the normal greenhouse. It would appear that the high rate of evaporation in the fan room was responsible for this change, which was statistically significant, however, only in the sponge parenchyma and for the total blade thickness.

Table III. Comparison of tissues of *Gaylussacia baccata* leaves collected 6-26-29 from plants grown under different conditions. The comparison is made on a basis of the statistical value (V) of the difference between mean measurements.

Tissue		Fan room compared with field; evaporation ratio, 3.12 to 1.00		Greenhouse compared with field; evaporation ratio, 1.12 to 1.00		Fan room compared with greenhouse evaporation ratio, 3.12 to 1.12	
		D and p.e.	V	D and p.e.	V	D and p.e.	V
Upper cuticle	MV	1.28 ± 1.5	.3X—	1.45 ± .28	5.0X—	.17 ± 1.48	.1X+
	M	.52 ± .39	1.3X+	.69 ± .37	2.0X+	.17 ± .22	.7X—
Upper epidermis	MV	10.02 ± .31	32.0X+	9.9 ± .30	33.0X+	.12 ± .26	.5X+
	M	11.0 ± 1.4	8.0X+	8.2 ± 1.25	6.5X+	2.78 ± 1.01	2.7X+
Palisade mis	MV	12.1 ± 3.87	3.1X+	16.4 ± 5.27	3.1X+	4.3 ± 4.3	1.0X—
	M	39.0 ± 6.5	6.0X+	44.0 ± 6.5	7.0X+	4.4 ± 1.61	2.6X—
Sponge parenchyma	MV	32.6 ± 3.5	9.3X+	20.9 ± 3.0	6.9X+	11.7 ± 2.5	4.7X+
	M	12.8 ± 4.7	2.7X+	7.6 ± 3.9	1.9X+	5.2 ± 4.0	1.3X+
Lower epider-	MV	4.6 ± 1.1	4.2X+	4.0 ± 2.5	1.6X+	.6 ± 2.3	.2X+
	M	2.3 ± 1.02	2.3X+	3.8 ± .9	4.2X+	1.5 ± .85	1.7X—
Lower cuticle	MV	.6 ± .15	4.0X—	.2 ± .43	.4X—	.4 ± .43	.9X—
	M	.13 ± .13	1.0X—	.04 ± .12	.3X+	.17 ± .12	1.4X—
Total blade	MV	56.4 ± 3.7	15.0X+	50.7 ± 7.2	7.0X+	6.7 ± 7.1	.9X+
	M	67.8 ± 5.5	12.0X+	65.8 ± 4.9	13.0X+	2.0 ± 4.0	.5X+

D equals the difference between the two averages, for June and October.
V equals the statistical value of the difference as shown by its probable error (p.e. of D).
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.
+ means that the tissue from field grown plants is thicker than that with which it is compared. In the last column it means that the greenhouse grown tissue is thicker.

Table IV. Comparison of tissues of *Gaylussacia baccata* leaves from plants grown under different conditions. Collected 10-2-29.

Tissue		Fan room of greenhouse; evaporation ratio, 4.00		Normal greenhouse; evaporation ratio, 1.56	
		N	Mean and p.e.	N	Mean and p.e.
Upper cuticle	MV	10	2.46 ± .29+	10	1.53 ± .09—
	M	10	1.87 ± .13+	10	1.53 ± .08+
Upper epidermis	MV	10	20.2 ± .79+	10	19.2 ± .67+
	M	10	18.7 ± .48+	10	19.2 ± .51—
Palisade	MV	10	37.1 ± 2.10+	10	33.15 ± 1.25+
	M	10	38.9 ± 1.78+	10	40.1 ± 1.96+
Sponge parenchyma	MV	10	56.27 ± 1.74+	10	57.7 ± 1.96+
	M	10	56.8 ± 1.44+	10	51.1 ± 3.38+
Lower epidermis	MV	10	15.2 ± .43+	10	11.05 ± .44—
	M	10	17.1 ± .58+	10	11.3 ± .31—
Lower cuticle	MV	10	1.95 ± .19+	10	1.15 ± .10—
	M	10	1.53 ± .11+	10	1.36 ± .12+
Total blade	MV	10	132.6 ± 2.40+	10	118.8 ± 2.34—
	M	10	134.5 ± 2.66+	10	123.7 ± 3.59+

N equals the number of leaves used to obtain the mean.
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.
The means are given in microns for the thickness of each tissue.
+ means that these means are greater than those for June.

Any work of this kind impresses one with the variability encountered and it becomes increasingly apparent that work which is based on material not carefully selected or statistically controlled can have little significance. In collecting leaf material for habitat contrast one should keep in mind the height of insertion of the leaves, their general size, and exposure. If this is carefully done and material for sectioning is taken from comparable places in the leaf blade the varia-

bility will be greatly reduced. Thus the number of leaves which will have to be examined will be considerably lessened. Tables of extremes and median measurements were prepared but are not considered to be worth the space they would occupy. It is sufficient to state that the extremes lay at an average of about 30 to 35 per cent of the median from the median, i. e. if a median blade thickness is 100 microns the extremes will be about 35 microns on either side. This was variable, of course. Also, the task of computing the average per cent of deviation of the variants from each mean was not considered worth the labor of twelve hundred odd computations involved. Enough was done, however, to indicate that the average deviation seldom exceeded ten per cent when ten leaves were used for the mean. The following data is probably characteristic: a) average deviation from the mean for total blade thickness of *Gaylussacia baccata* grown in the fan room, mid vein region 9.2 per cent, leaf margin region

Table V. Comparison of tissues of *Gaylussacia baccata* leaves collected 6-26-29 and 10-2-29 from plants grown in the fan room of a greenhouse. Evaporation ratios: 4.00 for October and 3.12 for June, as compared with field conditions at 1.00.

Tissue		Change in thickness	D in microns	p.e. D	V
Upper cuticle	MV	2.38 — 2.46	.08 plus	.32	.2X
	M	1.61 — 1.87	.26 "	.22	1.2X
Upper epidermis	MV	17.68 — 20.20	2.52 "	.98	2.5X
	M	16.60 — 18.70	2.10 "	.96	2.2X
Palisade	MV	35.70 — 37.10	1.40 "	2.70	.5X
	M	36.0 — 38.9	2.90 "	2.14	1.3X
Sponge parenchyma	MV	44.37 — 56.27	11.90 "	2.8	4.2X
	M	40.30 — 56.80	16.50 "	3.6	4.5X
Lower epidermis	MV	14.7 — 15.2	.50 "	.71	.7X
	M	13.8 — 17.1	3.30 "	.91	3.6X
Lower cuticle	MV	1.7 — 1.95	.25 "	.23	1.1X
	M	1.19 — 1.53	.34 "	.30	1.1X
Total blade	MV	116.4 — 132.6	16.20 "	3.90	4.15X
	M	109.2 — 134.5	25.30 "	4.23	6.0X

V equals the statistical value of the difference as shown by its probable error (p.e. of D).
D equals the difference between the two averages, for June and October.
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.

10.8 per cent; b) grown in the greenhouse, midvein region 8.4 per cent, leaf margin region 8.1 per cent; c) grown in the field, midvein region 5.3 per cent, for the leaf margin region 7.9 per cent.

Vaccinium vacillans

The low, dryland blueberry, *Vaccinium vacillans*, was studied in the same manner as the huckleberry previously de-

Table VI. Comparisons of tissues of *Vaccinium vacillans* leaves from plants grown under different conditions. Collected 6-26-29.

Tissue		Fan room of greenhouse; evaporation ratio, 3.12		Normal greenhouse; evaporation ratio, 1.12		Characteristic field habitat; evaporation ratio, 1.00	
		N	Mean and p.e.	N	Mean and p.e.	N	Mean and p.e.
Upper cuticle	MV	10	2.8 ± .18	10	2.04 ± .13	10	3.14 ± .20
	M	10	2.38 ± .17	10	2.38 ± .34	2	2.55 ± .57
Upper epidermis	MV	10	18.4 ± .60	10	22.1 ± .94	10	16.3 ± .76
	M	10	18.5 ± .63	10	19.6 ± .78	2	14.4 ± 2.87
Palisade	MV	10	75.1 ± 1.93	10	78.9 ± 3.47	10	100.7 ± 3.46
	M	10	78.7 ± 3.25	10	62.0 ± 3.76	2	100.3 ± 4.59
Sponge parenchyma	MV	10	64.8 ± 3.12	10	51.0 ± 3.04	10	87.5 ± 5.09
	M	10	63.4 ± 1.17	10	50.0 ± 3.59	2	74.8 ± 12.61
Lower epidermis	MV	10	14.4 ± .88	10	13.9 ± .33	10	11.2 ± .43
	M	10	16.0 ± .25	10	13.9 ± 1.00	2	10.6 ± .27
Lower cuticle	MV	10	2.8 ± .21	10	1.61 ± .16	10	3.8 ± .29
	M	10	2.3 ± .17	10	2.1 ± .39	2	2.97 ± 1.43
Total blade	MV	10	175.8 ± 5.24	10	171.3 ± 5.11	10	222.7 ± 5.15
	M	10	179.9 ± 3.55	10	148.3 ± 2.69	2	205.7 ± 6.88

N equals the number of leaves used to obtain the mean.
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.
The means are given in microns for the thickness of each tissue.

Table VII. Comparison of tissues of *Vaccinium vacillans* leaves collected 6-26-29 from plants grown under different conditions. The comparison is made on a basis of the statistical value (V) of the difference between mean measurements.

Tissue		Fan room compared with field; evaporation ratio, 3.12 to 1.00		Greenhouse compared with field; evaporation ratio, 1.12 to 1.00		Fan room compared with greenhouse evaporation ratio, 3.12 to 1.12	
		D and p.e.	V	D and p.e.	V	D and p.e.	V
Upper cuticle	MV	.34 ± .27	1.3X+	1.1 ± .23	4.8X+	.76 ± .22	3.4X—
	M	.17 ± .59	.3X+	.17 ± .67	.3X+	0 ± 0	0X+
Upper epidermis	MV	2.1 ± .97	2.2X—	5.8 ± 1.21	4.8X—	3.7 ± 1.1	3.4X+
	M	4.1 ± 2.9	1.4X—	5.2 ± 2.9	1.8X—	1.1 ± .99	1.1X+
Palisade	MV	25.6 ± 3.9	6.5X+	21.8 ± 4.8	4.5X+	3.8 ± 3.9	1.0X+
	M	21.6 ± 5.6	4.0X+	38.3 ± 5.9	6.5X+	16.7 ± 5.0	3.3X—
Sponge parenchyma	MV	22.7 ± 5.9	3.8X+	36.5 ± 5.9	6.0X+	13.8 ± 4.3	3 2X—
	M	11.4 ± 12.6	.9X+	24.8 ± 13.1	1.9X+	13.4 ± 3.8	3.5X—
Lower epidermis	MV	3.2 ± .97	3.3X—	2.7 ± .54	5.0X—	.5 ± .94	.5X—
	M	5.4 ± .37	14.0X—	3.3 ± 1.03	3.0X—	2.1 ± 1.3	1.6X—
Lower cuticle	MV	1.0 ± .35	3.0X+	2.2 ± .33	6.0X+	1.2 ± .26	4.6X—
	M	.67 ± 1.44	.4X+	.87 ± 1.5	.6X+	.2 ± .42	.5X—
Total blade	MV	46.9 ± 7.3	6.4X+	51.0 ± 7.2	7.0X+	4.5 ± 7.3	.6X—
	M	25.8 ± 7.7	3.3X+	57.4 ± 7.3	7.8X+	31.6 ± 4.5	7.0X—

D equals the difference between the two averages, for June and October.
V equals the statistical value of the difference as shown by its probable error (p.e. of D).
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.
+ means that the tissue from field grown plants is thicker than that with which it is compared. In the last column it means that the greenhouse grown tissue is thicker.

scribed. The results are given in Tables (V, VI, VII. VIII,) which are similar to Tables (II, III, IV) for Gaylussacia. The same general relations hold for Vaccinium as for Gaylussacia but the blueberry is shown to be considerably more variable and less satisfactory to work with.

One interesting variation appears in the thickness of the upper epidermis which was uniformly less in the field grown

Table VIII. Comparison of tissues of *Vaccinium vacillans* leaves from plants grown under different conditions. Collected 10-2-29.

Tissue		Fan rom of greenhouse; evaporation ratio, 4.00		Normal greenhouse; evaporation ratio, 1.56	
		N	Mean and p.e.	N	Mean and p.e.
Upper cuticle	MV	10	2.04 ± .22	9	2.93 ± .25
	M	9	3.68 ± .44	10	2.21 ± .19
Upper epidermis	MV	10	17.85 ± .917	9	18.9 ± .82
	M	9	13.6 ± .73	10	19.7 ± .77
Palisade	MV	10	40.97 ± 2.33	9	58.3 ± 2.2
	M	9	27.96 ± .93	10	43.7 ± 2.29
Sponge parenchyma	MV	10	48.3 ± 2.02	9	35.3 ± 1.62
	M	9	46.8 ± 4.27	10	42.8 ± 2.26
Lower epidermis	MV	10	13.1 ± .66	9	15.4 ± .59
	M	9	11.5 ± .72	10	13.8 ± .72
Lower cuticle	MV	10	2.55 ± .17	9	2.27 ± .25
	M	9	2.8 ± .40	10	2.7 ± .23
Total blade	MV	10	124.6 ± 1.51	9	132.6 ± 2.37
	M	9	106.8 ± 5.61	10	125.3 ± 2.10

N equals the number of leaves used to obtain the mean.
MV equals the leaf sections from the midvein region.
M equals the leaf sections from the leaf margin region.
The means are given in microns for the thickness of each tissue.

plants than it was in either of the greenhouse grown plants, and significantly so in half of the comparisons. The palisade varied from one to three layers thick in different leaves from different habitats. For the greenhouse grown plants the palisade averaged 1.3 cells thick, in the fan room the development was greater, averaging 2.0 rows thick, while in the field it averaged 2.6 rows. Examination of the palisade/sponge parenchyma ratio reaveals that the palisade was uniformly slightly thicker than the sponge (although not very much). The average ratios are as follows: for the fan room 1.2, for the normal greenhouse room 1.39, and for the field 1.24, which variation is not so great as for Gaylussacia.

DISCUSSION

Most of the points of contrast have been discussed in the body of the paper. Only a general consideration of the influence of the habitat remains. The great contrast is between field grown plants and greenhouse grown plants. Little or no contrast is shown between plants grown in the fan room of the greenhouse and in an ordinary greenhouse room with about one-third the evaporation. Since the differences do not correlate with evaporating power of the air, as measured by the Livingston atmometers, other factors must be looked for.

Conditions in the two greenhouses were entirely comparable except for the rate of evaporation. Since the soil moisture supply was adequate at all times it can be suggested that a high rate of transpiration does not result in strong tissue modification as long as there is no water deficit. (Undoubtedly the transpiration was much greater in the fan room, with the atmometer loss of about 400 cc. per week. No transpiration measurements were made, however.) Experiments are planned for 1933 in which the plants transferred to tubs, will be exposed to a high rate of evaporation, (some both under high and low soil moisture tubs with high soil moisture conditions and some with dry soil conditions.) This should show a distinction between these two factors and their effect on tissue plasticity.

Between the greenhouse conditions and those of the native habitat there are, of course, several contrasting factors. The

evaporating power of the air is considerably less in the field than in the fan room, and more variable. The soil moisture supply was not adequate at all times in the field, atmospheric humidity conditions were undoubtedly different, as were soil and air temperatures. All factors in the field were subject to greater variation, diurnally and seasonally. Another factor, and probably significant in production of greater thickness of tissues of the field grown plants, is that of light quality. The ordinary glass of the greenhouse rooms filters out many rays, especially the important ultra violet rays. The 1933 experiments are to consider also that factor by the use of a glass substitute which transmits ultra-violet light. Thus it is expected that we will have better information on phenotypic variation of leaf tissues.

SUMMARY AND CONCLUSIONS

1) Plants of *Gaylussacia baccata* (Wang.) C. Koch. and *Vaccinium vacillans* Kalm. were transplanted from their native habitat to two greenhouse rooms, one with a high rate of evaporation produced by a large electric fan. The transplants were made in the spring before the buds had begun to swell and the study was continued throughout the season.

2) Comparative anatomical studies of the leaves from plants grown in each of the conditions were made: a) the native field condition with an average weekly evaporation of 121 cc. from Livingston spherical atmometers. This was taken as unity for a comparison of the other situations. b) the normal greenhouse with an evaporation ratio of 1.12, and c) the fan room with an evaporation ratio of 3.12. Except for the evaporation conditions the two greenhouse rooms were entirely comparable.

3) Two striking generalizations can be made (detailed points are brought out in the paper): a) the tissues of the leaves of the plants from the two greenhouse conditions did not differ materially, despite the great difference in evaporation. This is tentatively attributed to the fact that the plants were watered frequently so that the soil was always in good tilth. It is assumed that the transpiration rate of the plants in the fan room was materially higher than that of the plants

in the normal greenhouse room, and that a high evaporation power of the air is unimportant as an influence on tissue proportions as long as the water-supplying capacity of the soil is adequate to prevent the development of a water deficit in the plants. b) The tissues and total blade thickness of the field grown plants were generally and conspicuously thicker than those of either of the greenhouse grown plants. Factors which may have effected this difference are soil moisture deficit, which developed at intervals during the season, and ultraviolet light of the field habitat. Further experimentation is designed to study these factors.

4) The data are presented in a statistical manner, which is deemed necessary for comparative studies, since considerable variation is encountered among different leaves.

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AN ECOLOGICAL STUDY OF THE COLEOPTEROUS FAUNA OF A TAMARACK SWAMP.

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There has long been an idea prevalent in the minds of many naturalists that the fauna of Tamarack Swamps is principally of boreal origin. To ascertain if this were the actual condition, and realizing that the beetle fauna of any region furnishes as good, if not better, criterion for the proper solution of the question as any assemblage of organisms, the authors made colections of the beetles of one of the southernmost tamarack swamps in this part of the country.

The swamp selected for study is located in Porter County, Indiana, Westchester Township, three-eighths of a mile northwest of the Chicago, Lake Shore and South Bend Electric Railway, stopping point Mineral Springs; it is three miles northwest of the nearest town, Porter. Its nearest approach to Lake Michigan is nearly a mile, with several high sand dunes intervening, the nearest residence is fully a quarter of a mile distant from the swamp. The swamp comprises an area of about sixty acres. It is situated in the Transition Life Zone not more than ten miles from the northern border of the Upper Austral Life Zone.

Mr. Gerrit S. Miller, Jr., (Science, N. S., VII, 1898, p. 615) says, "While every life zone undoubtedly has its outlying islands, perhaps the best known instances of the phenomenon are the small boreal areas scattered through the transition zone and northern part of the upper austral life zone in the eastern United States. Many of the boreal islands are found on mountain tops, where their presence is readily explained by the low temperature of high elevations, but others also occur practically at sea level, or at an altitude much below that normally attained by the zone in which they be." Mr. Vernon Bailey (Science, N. S., III, 1896, pp. 250-251) under the title

"Tamarack Swamps as Boreal Islands," mentions the fact that "the Eastern tamarack (*Larix Americana*) is generally considered a boreal tree. East of the Rocky Mountains it overreaches the Boreal Zone, and occurs in scattered swamps throughout the transition and even in the northern part of the Upper Austral Zone. Such swamps are common in central Pennsylvania, northern Ohio, southern Michigan and northern Indiana, though the line marking the southern limit of the Boreal Zone is drawn much farther north." Continuing Mr. Bailey remarks that, "The vegetation of these swamps is composed largely of boreal species of plants, including the white birch, cassandra, andromeda, cranberries, pitcher plants, many species of northern grass, carex, herbaceous plants, mosses, and a carpet of sphagnum five to eight inches thick, as porous and absorbent as a sponge. The stems and leaves of sphagnum have a peculiar porous structure, through which a constant flow of water is carried up and poured out to evaporate on the surface. Thus by constant evaporation the plant and its surrounding atmosphere are kept cold. Ice was found under sphagnum in one of these swamps as late as May 10, although the preceding winter had been mild and the snow had all disappeared by the middle of March."

Most of the plants mentioned by Mr. Bailey were found to occur at the Mineral Springs swamp. Upon the open quaking bogs the pitcher plant (*Sarracenia purpurea* L.) is not uncommon; here also occurred the monkey-flower (*Mimulus ringens* L.), the round-leaved sun-dew (*Drosera rotundifolia* L.), loosestrife (*Decodon verticillatus* [L.] Ell.). The broad-leaved cat-tail (*Typha latifolia* L.) is quite conspicuous along the rift through the middle of one of the bogs (near station VII), the broad-leaved arrow-head (*Sagittaria latifolia* Willd.) is less in evidence and only occurs near the margin at white cedar lobe. The poison sumac (*Rhus vernix* L.) and an occasional clump of willow (*Salix longifolia* Muhl. and *S. candida* Fluegge) occur on the bog, where also Joe-Pyeweed (*Eupatorium maculatum* [L.] Dart.) occurs abundantly and young tamaracks (*Larix laricina* [Du Roi] Koch) are invading the margin. In the swamp proper occur the larger tamaracks with an admixture of white pines (*Pinus strobus* L.); as the bog side

margins are approached the poison sumac assumes a good growth and in places is quite dense, the poison ivy (*Rhus toxicodendron* L.) is also very abundant. The speckled alder (*Alnus incana* L.) grows sparsely in some of the lower moist margins; yellow birch (*Betula lutea* Michx.) grows sparsely through the northward lobe or extension of the forest and also along the old trail at the hillside margin; here also swamp or red maple (*Acer rubrum* L.) may be found; the black or sour gum (*Nyssa sylvatica* Marsh) is more abundant here and along the margin of the north lobe a goodly fringe of *Sassafras variifolium* Salisb., borders the trail. At the eastern end of the swamp are a few witch hazels (*Hamamelis virginiana* L.) and a growth of the steeple bush (*Spiraea tomentosa* L.); the latter was productive, while in blossom, of many species of beetles. At the southern side of the swamp and separating the two open bogs is a white cedar or arbor vitae (*Thuja occidentalis* L.) lobe or extension of the swamp. However, no material was collected within this area. A conspicuous plant along the trail and at bog margins of the cedar lobe and even extending a few feet upon the bog is skunk cabbage (*Symplocarpus foetidus* Salisb.); it was, however, quite rare in the forest.

No attempt is made to record completely the herbaceous vegetation of the swamp but the following were observed:

Smilacina racemosa (L.) Desf., False Spikenard. Profuse.

Osmunda cinnamomea L., Cinnamon Fern. Profuse.

Osmunda regalis L., Flowering Fern. Not infrequent.

Polygonum Hydropiper L., Smartweed. Frequent along trail.

Rubus hispidus L., Running Swamp Blackberry. Frequent along trail.

Pilea pumila (L.) Gray, Clearweed. Frequent.

Chelone glabra L., Snakehead. Infrequent.

Medeola virginiana L., Indian Cucumber. Rare.

Impatiens biflora Walt., Spotted Touch-me-not. Common at eastern entrance of trail to swamp and at bog side margin.

Maianthemum canadense Desf., Two-leaved Solomon's Seal. Frequent.

Lobelia siphilitica L., Great Lobelia. Scattering.

Cyperus filiculmis Vahl, Slender Cyperus. Frequent in trail.

Tithymalopsis corollata (L.) Kl. et G., Flowering Spurge. Rather frequent.

Aster umbellatus Mill., Tall flat-top White Aster. Not rare.

Helianthus grosseserratus Martens. At entrance of trail to swamp; not rare.

Prenanthes alba L., Rattlesnake-root. Frequent.

Campanula rotundifolia L., Harebell. Not common.

Oenothera rhombipetala Nutt., Rhombic evening-primrose. Scarce.

Galium triflorum Michx., Fragrant Bedstraw. Abundant.

Solidago canadensis L., Canada Goldenrod. Sparse growth along trail and bog side margin of swamp.

Eupatorium maculatum (L.) Darl., Joe-Pyeweed or Purple Boneset. Rare.

Mitchella repens L., Partridge Berry. Forms a ground cover in a large part of the swamp.

Psedera quinquefolia (L.) Greene, Virginia Creeper. Rather abundant.

Sambucus pubens Michx., Red Berried Elder. Not rare.

Ceanothus americanus L., Jersey Tea. Frequent at bog margins.

Ilex verticillata (L.) Gray, Winter Berry. Frequent at bog margins.

Dasystephana flavida (A. Gray) Britton, Yellow closed Gentian. Frequent at bog margins.

Viola incognita Brainerd var. *Forbesii* Brainerd, Northern White Violet. Abundant throughout the swamp. (Lyon, 1930, states that specimens of white violets

from Mineral Springs in the Deam Herbarium were identified as this species by Brainerd.)

Ribes setosum Lindl., Bristly Gooseberry. Not common near trail margin.

Cypripedium parviflorum var. *pubescens* (Willd.) Knight. Near bog margins.

A low cranberry (*Oxycoccus macrocarpon* (Ait.) Pursh.) occurs rarely on the bogs and the twin-flower (*Linnaea borealis* L.) was found once, at the edge of the trail through the north lobe of the swamp. This list of plants is intended to show the condition of the swamp flora during the time when the senior author was making the collections upon which this study is based. Additional plant records and descriptions of more recent aspects of the flora of the locality can be found in publications by Lyon (1927, 1930), by Pepoon (1927) and by Peattie (1930).

The following note written by the senior author at the close of twelve years of collecting indicates some of the changes which were taking place in the swamp during that period. "At the time when this investigation was started the condition of the swamp was primitive, the forest being very dense, with very large tamaracks numerous, the floor very weak and quite wet, open pools of water quite numerous, and the sphagnum moss very luxuriant. Some two or three years later the dying tamaracks presented the appearance at a distance known as 'Red-Tops'; the death of these trees weakened them so that they soon began to fall, at least, as far as the surrounding trees would permit, the gradual elimination of these trees allowed many of the other trees to be uprooted by storms, settlers soon began to cut and haul away most of these windfalls during the winter when they could invade the swamp with safety. The temperature was quite cool at first due to the rapid evaporation afforded by the sphagnum moss, but gradually rose as the swamp became less moist. Now, after less than a decade and a half, as a result of man's agency, much aided by the automobile which all too often brings not nature lovers but vandals, the swamp is but a very shadow of its former self and the writer feels that it is scarcely deserving of being designated as a 'tamarack' swamp."

When the junior author visited the locality in 1925 at the end of a dry season the outlying parts of the swamp were rather dry but the bog and adjacent margins were still moist —the pitcher plant was rather common. The locality has been closed to the general public by the conversion of the surrounding territory into an exclusive lake resort, and statements by naturalists who have visited the locality more recently indicate that the tendency to destruction of the swamp has been checked if not actually reversed. Dr. V. E. Shelford writes (in litt., April 24, 1929) "I have visited the swamp . . . once a year for the past few years and have found it recovering from an epidemic of bark beetles which destroyed about half of the tamaracks about 1910-1912." Dr. M. W. Lyons, Jr., (in litt., Jan. 8, 1930) wrote the following notes, "The forest floor is still wet . . . the tamarack trees are numerous . . . the sphagnum is luxuriant and abundant."

The senior author collected in the swamp at infrequent intervals from 1910-1922, during the warmer months of the year (May to September, inclusive) only, as it was believed that many visitors from outside areas would seek, the shelter afforded by the numerous logs, loose bark, sphagnum, etc., for the purpose of hibernation during the colder months. It is true, of course, that a number of the species taken in the late spring, summer and early autumn may be merely chance visitors or adventurers.

The junior author spent the first four days of September, 1925, collecting in the swamp and surrounding territory.

As was to be expected the conifer feeding species, many of which are restricted to one food plant, were much in evidence. The cup-shaped leaves of the pitcher plant gave a few species not taken elsewhere in the swamp. One of the surprising features of the work was the entire absence of the family Cicindelidae; search was made especially for *Cicindela ancocisconensis* Harr., which has been recorded by Blatchley as occurring in similar situations in Fulton County, only 55 or 60 miles southeast of Mineral Springs.

Several distinctly northern forms are included in the list, but most of the species found in the swamp have also been

taken previously in the same general region, where, in the wash-up of Lake Michigan, and in other situations, many boreal species, as *Carabus meander* Fisch., *Bembidion nitidum* Kirby, *Amara subaenea* Lec., *Aleochara bipustulata* L., *Coccinella trifasciata* L., and *Cryptophagus acutangulus* Gyll., have been taken. The occurrence of some species known only from Florida and the Gulf States presents, as does the occurrence of the Tupelo or Sour Gum, a problem in distribution of biota which is difficult to explain.

Because of the extent and scattered sources of literature on *Coleoptera*, specialists in certain groups were asked to examine the lists of their specialties and furnish information on the distribution of the forms included. Such information was furnished in the latter part of 1926 for such species as had been collected prior to 1925 by the following entomologists: Howard Notman (Carabidae and Staphylinidae), W. M. Blackman (Scolytidae), J. N. Knull (Cerambycidae), H. F. Wickman (Tenebrionidae, Melandryidae, Anobiidae), C. W. Leng (Coccinellidae, Alleculidae), H. C. Fall, (Lampyridae, Cantharidae, Melyridae, Nitidulidae, Anthicidae, Colydiidae, Lanthridiidae), W. S. Fisher (Buprestidae), E. C. Van Dyke (Elateridae), Ralph Voris (Staphylinidae), F. E. Blaisdell (Histeridae), L. L. Buchanan (Curculionidae), and Charles Schaeffer (Chrysomelidae, Mylabridae). In almost every case the opinion that the species included in the list examined, indicated a fauna not distinctly boreal was expressed.

The Scolytidae found here are, as a whole, rather northern and Doctor Blackman wrote, "I have found the same general tendency toward an apparent southern extension of various more northern species into swampy areas. It is somewhat of a question in my mind as to whether this is entirely due to the direct influence of the swamp or whether it may not in part at least be due to swampy areas having been less disturbed by man and the fauna as well as the flora less changed from the original condition." Mr. Leng observed that, "A conspicuous feature of your list of Coccinellidae is the total absence of distinctly southern species." However, Professor Wickham's statements, "I do not see a single one on the list

submitted that appeals to me as being in the least characteristic of boreal or alpine surroundings. In general they are forms of wide distribution and with decided tolerance for a wide range of environmental factors" and Mr. Buchanan's observation that, "On the whole, the list of curculionids consists of species of rather wide range,—wide enough so that they would reasonably be expected to inhabit the region under discussion," would seem to indicate the nature of the list as a whole.

The list of species from Mineral Springs was compared with lists from three other localities—Bloomington, Illinois (Wolcott, 1895, 1896), Bayfield, Wisconsin (Wickham, 1895) and Charlevoix County, Michigan (Hatch, 1924)—in an attempt to determine if a greater percentage of the species from the swamp than of those from another locality in the same general region (Bloomington) would be found in a list from a more northern region. The results of this study are shown in the accompanying table. There is no significant difference between the number of species common to Mineral Springs and either or both of the northern localities and the number common to Bloomington and the northern localities, but the

	Bayfield	Charlevoix County	Combined Lists Bayfield and Charlevoix County
Mineral Springs (393)	114 29.0%	113 28.7%	164 41.7%
Common to Mineral Springs and Bloomington (67)	38 56.7%	39 58.2%	46 68.6%
Bloomington (337)	108 32.1%	109 32.3%	148 43.9%

A table showing the numbers and percentages of the species in the lists from Mineral Springs (Indiana) and Bloomington (Illinois) which are also included in the lists from Bayfield (Wisconsin) and Charlevoix County (Michigan).

small difference which does exist is in favor of the Bloomington list!

The large number of species which reach their northern limit and the similar number which have their most southern extension here indicate that the fauna belongs to the Transition Life Zone.

Records of distribution or the limits of distribution as obtained from literature and supplemented by data furnished by correspondents are included for species either distinctly northern or distinctly southern, for those which reach their farthest north or south extension here and for those recorded as new to Indiana. Those species for which no distribution notes are included extend, as a rule, considerable distances both north and south of this region.

Final determination of insect faunal zones in North America and accurate interpretation of the faunal characteristics of any locality must wait many years yet,—until much more information on the distribution of species and adequate knowledge of the abundance of each in different localities are obtained.

No claim is made that the accompanying annotated list contains all the species that might be found in this restricted environment, each trip yielding some forms not taken previously. The number of specimens recorded, is not, in most cases, to be considered as an index of their relative abundance, the prime object being to secure in the time at the collectors' disposal as many representative forms as possible. Enough material has been collected and studied, however, the authors believe, to form a basis for the conclusions given.

Collections and field notes prior to 1925 should be credited to the senior author, those of 1925 to the junior author. The junior author has prepared the manuscript but the original notes of the senior author including much of the information on distribution compiled from literature form the basis of the study, to which have been added such facts as the junior author has obtained from collections in 1925, correspondence with specialists and some study of literature.

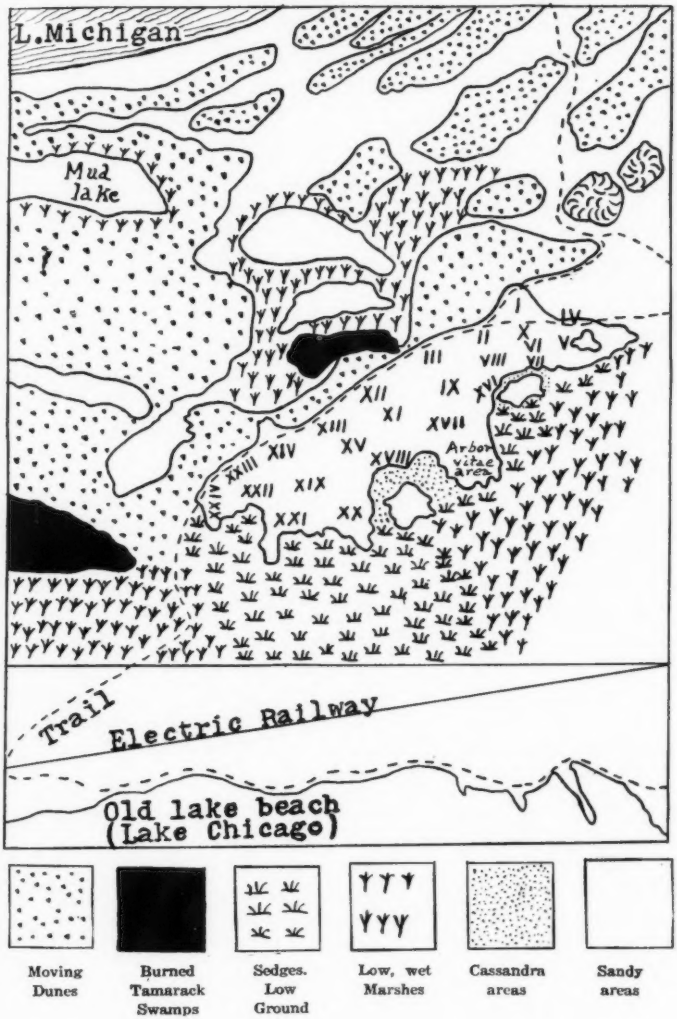
The material collected in 1925, except the most common species, which were determined by the junior author, were identified by L. L. Buchanan (Carabidae and Curculionidae), E. C. Van Dyke (Elateridae), J. W. Swaine (Scolytidae), H. S. Barber (Lampyridae, Helodidae, Scaphidiidae, and Chrysomelidae), E. A. Chapin (Coccinellidae, Staphylinidae, Tenebrionidae, Nitidulidae, and Melandryidae) and W. S. Fisher (other families). The senior author was aided in determining such species as he did not readily recognize by H. C. Fall, W. S. Blatchley, H. F. Wickham, J. D. Hood, Albert Fenyes, and Emil Liljeblad.

The late O. E. Lansing kindly made determinations of various trees, shrubs and other plants, and D. C. Peattie has also identified several herbaceous plants. M. W. Lyon, Jr., read the manuscript in its early stages and made many valuable suggestions.

The authors wish to express their appreciation and obligation to all of the specialists named above for the aid which they gave, and to B. B. Fulton, Emil Lilijeblad, William J. Gerhard, H. S. Stoddard, and V. E. Shelford, all of whom have freely parted with specimens of Coleoptera taken at the swamp.

The numbers and the nomenclature used is that of Leng's catalogue (Catalogue of the Coleoptera of America, North of Mexico. 1920, Sherman, Mount Vernon, N. Y.).

A map of the swamp and its surroundings is included to show the character of the region and to indicate the exact location of captures. Roman numerals indicate the collecting stations in the swamp and these same numerals are cited in the record of capture of most of the specimens.



Map of tamarack swamp at Mineral Springs and vicinity.

(Roman numerals within the swamp refer to collecting stations cited in the list of captures.)

CARABIDAE

170 *Carabus sylvosus* Say. July 3, 1911, crawling on ground within circle of light from collecting lamp, near II.

171 *Carabus serratus* Say. With the preceding species.

204 *Colosoma calidum* Fab. July 3, 1911, with the preceding species; June 10, 1922, ascending trunk of hard maple tree, II.

246 *Notiophilus aeneus* Hbst. Sept. 12, 1920, sifting damp leaves and debris, X.

309 *Pasimachus punctulatus* Hald. July 3, 1911, crawling on leaf-covered ground within circle of light from lamp, II. Ind. Ill. Mo.—Ala. Leconte (1850) calls attention to the absence of this genus at Lake Superior.

*404 *Nomius pygmaeus* (Dej.). Aug. 15, 1920. One specimen and thorax of a specimen, on moist soil under damp leaves and badly decayed log; II. While removing the leaves and before the beetle was found an exceedingly offensive odor was noticed. The habit possessed by this insect of exuding an ill-smelling liquid when disturbed has been noted by a number of writers. Notman writes (in litt.) "*N. pygmaeus* is not known to me from elsewhere (than Adirondacks) and is probably the most distinctly boreal species in your list," but Leng gives "Ga. L. Sup. So. Europe" and Blatchley quotes its range thus, "New Jersey, Canada and L. Superior, southward and westward to California."

592 *Bembidion chalceum* Dej. June 16, 1916 (Dr. Wells). Ind. Ia. Colo. Can. (Casey & Leng), Notman (in litt.), "My collecting indicates that *Bembidion chalceum* is almost completely replaced by *B. honestum* below 1000 feet elevation in the Adirondack Mts."

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*Species and varieties new to the Indiana state list are indicated by an asterik.

651 *Bembidion patruele* Dej. One specimen with the following species. Ind. L. Sup. N. Y. Pa. Ia.

*695 *Bembidion constrictum* (Lec.). July 3, 1911, at collecting light, II. Casey gives distribution as New Jersey to Texas and adds: "*Constrictum* seems to be more essentially a maritime species, or at least I have seen no specimens taken far from seashore." Leng (1920) gives "N. Y. Fla. Tex." with varieties in New Jersey and Texas. Blatchley states "wide distribution over the eastern United States."

723 *Bembidion versicolor* (Lec.). With the two preceding species. Notman (in litt., Oct. 25, 1926), "*B. versicolor* is the only species listed occurring in the alpine zone of the Adirondacks but it has a wide range occurring also in Rockland Co., in southern N. Y." L. Sup. (LeConte), Mt. Washington, N. Y., to N. Ill. and Duluth, Minn. (Casey). Nfld. L. Sup. Ind? B. C.? Sask. (Leng).

805 *Tachyura incurva* (Say). Sept. 10, 1911, under bark on large dead white pine, III.

883 *Tachys laevus* (Say). Sept. 11,1911, sifting sphagnum moss, XII.

892 *Tachyta inornata* (Say). Sept. 10, 1911, III; Sept. 26, 1920, sifting sphagnum moss, X; May 9, 1915, under bark of tamarack sapling, V.

898 *Tachymenis flavicauda* (Say). With species no. 805.

901 *Patrobus longicornis* (Say). Sept. 2, 1910, under bark on dead tamarack tree, X; Sept. 5, 1920, an unusually small specimen (10 mm.), beneath small stick in trail, X; Sept. 11, 1911, same place and condition as preceding specimen, X; Sept., 1911, under log, II.

1006 *Pterostichus adoxus* (Say). May 31, 1910, "Tamarack Zone, ground under bark," (V. E. Shelford), II; May 9, 1915, under small log, IX; Aug. 15, 1920,

dug out of badly decayed log, (S. Paul Jones), XII; Aug. 20, 1911, IV, under bark of pine tree, V; Sept. 11, 1911, under stick in trail, X.

*1077 *Monoferonia osculans* (Csy.). May 31, 1920, under bark of white pine log, IV. Can. N. Y. Ill. Pa. Md. (Wickham). Ct. Md. Ill. (Leng).

1089 *Euferonia stygica* (Say). July 3, 1911, at light II; July 4, 1911, sweeping, XI; July 30, 1911, under bark of dead tamarack, VIII. Ind. Ill. Pa. N. Y. Mich. L. Sup.

1093 *Euferonia coracina* (Newn.). Sept. 9, 1903, two specimens, "tamarack-pine area, under pine log on ground." (V. E. Shelford).

1162 *Poecilus lucublandus* Say. May, "at bog margin" (V. E. Shelford).

1169 *Lophoglossus scrutator* (Lec.). var. *canadensis* Chd. May 9, 1915, under small tamarack log, IX. Ill. O. Can.

1174 *Omaseus caudicalis* (Say). Sept. 11, 1911, under small stick, IV.

1176 *Omaseus corvinus* (Dej.). Sept. 2, 1925, two specimens taken from leaves of pitcher plant on quaking bog.

1178 *Dysidius mutus* (Say). May 9, 1915, under tamarack log, IX.

1182 *Micromaseus patruelis* (Dej.). Aug. 15, 1920, beneath stick, X. Ind. N. Y.—L. Sup. Nfld.

1188 *Bothriopterus pennsylvanicus* (Lec.). Sept. 9, 1909, "under bark on ground Pine Zone," (V. E. Shelford); May 31, 1920, under bark of tamarack stump, XI; Sept. 2, 1925, sifted from leaves and debris in western portion of swamp. Ind. Pa. N. Y. (Leng). N. C. (Notman in litt.)

1372 *Celia musculus* (Say). Aug. 20, 1911, sifted from sphagnum moss, VI.

*1414 *Amara convexa* Lec. May 4, 1912, "open bog, dead in pitcher-plant" (V. E. Shelford), XVI. L. Sup.

1454 *Dicaelus purpuratus* Bon. July 3, 1911, crawling over fallen leaves within circle of light from collecting lamp, II. Ind. N. Y.—La. Fla.

1482 *Calathus gregarius* Dej. With the preceding species.

1513 *Platynus decens* Say. May 4, 1912, "Among young tamaracks, forest bog margin," (V. E. Shelford), VII; Sept.2, 1910, beneath bark of tamarack stump, X; Aug. 5, 1920, two specimens under a small piece of bark on a tamarack stump, XI; Sept. 3, 1925, in decaying tamarack log.

1514 *Platynus sinuatus* (Dej.). May 9, 1915, under tamarack log, IX; May 31, 1920, under dry leaves, X; Aug. 20, 1911, under bark of tamarack log, IX; Sept. 2, 1910, under bark of tamarack stump, X; Sept. 2, 1925, seventeen specimens and Sept. 4, 1925, seven specimens under bark of decaying logs and stumps.

—— *Platynus* sp. near *sinatus* (Dej.). but distinct from any described. Sept. 5, 1920, two specimens beneath bark on white pine stump, two beneath bark on tamarack stump, X.

1539 *Platynus tenuis* Lec. May 31, 1920, IV, V, X; two specimens under bark of tamarack logs, one under bark of white pine tree, two under leaves in trail. Ind. N. J.—Can. Nfld.

1541 *Platynus mutatus* G & H. May 9, 1915, under stick, two specimens, X, Ind. Pa.—Can. Blatchley says this is a member of the Boreal fauna.

1546 *Platynus affinis* (Kirby). July 3, 1911, at light, II; Aug. 20, 1911, in sphagnum moss. Ind. N. J.—Can.

*1547 *Platynus carbo* Lec. Aug. 20, 1911, in sphagnum moss, XI. L. Sup. Hudson Bay Terr.

1577 *Platynus aeruginosus* (Dej.). May 31, 1920, under bark of dead tamarack sapling, VII.

1581 *Platynus punctiformis* (Say). Aug. 20, 1911, sweeping, VII, under bark of pine log, XXI; Sept. 2, 1910, under bark on tamarack stump, (Wm. J. Gerhard), IX.

1584 *Platynus ruficornis* Lec. Aug. 20, 1911, under bark of dying tamarack tree, XVI; July 30, 1911, under bark of dead tamarack tree, VII.

1587 *Platynus picipennis* (Kirby). May 13, 1910, "surface of ground, open bog," (V. E. Shelford). Mass. Pa. Kans. (LeConte). L. Sup. Ont. (Casey). Leng's records not valid as this species is confused with other apparently valid species.

Platynus elongatulus Hald. May 31, 1920, under tamarack bark on ground, XI.

1588 *Platynus lutulentus* Lec. Sept. 2, 1910, sweeping XIII. Ill. N. Y. - Hudson Bay.

1592 *Platynus obscurus* Hbst. May 9, 1915, on ground under bark, two specimens, IX; May 31, 1920, under bark of log, VI.

1620 *Galerita bicolor* Drury. Sept. 1 and 4, 1925, under bark of decaying logs.

1636 *Tetragonoderus fasciatus* Hald. Sept. 11, 1911, sifted from sphagnum moss, XXIV.

1642 *Lebia atriventris* Say. Sept. 16, 1911, VIII.

1655 *Lebia viridis* Say. July 4, 1911, three specimens, VII; July 30, 1911, three specimens, II-III; Sept. 2, 1910, two specimens, XVII; Sept. 10, 1911, III. All taken by sweeping.

*1655b *Lebia moesta* Lec. May 31, 1920, under bark of dead tamarack, XI. L. Sup.

1658 *Lebia pumila* Dej. Sept. 4, 1925, sweeping vegetation among tamaracks.

1667 *Lebia ornata* Say. July 30, 1911, IV; Sept. 11, 1911,

III; both taken by sweeping; Sept. 1, 1925, sweeping vegetation among maples in eastern portion of swamp.

1672 *Lebia fuscata* Dej. Aug. 15, 1920, many seen and taken throughout swamp by sweeping low herbage, one dug out of badly decayed log.

1675 *Lebia scapularis* Dej. July 30, 1911, four specimens, II-III; Sept. 10, 15, 1911, X; Sept. 16, 1911, VII. All taken by sweeping; Sept. 3, 1925, sweeping in maple zone.

*1681b *Lebia vittata* Fab. var. *conjungens* Lec. Aug. 15, 1920, XI; Sept. 12, 1920, X; both by sweeping. N. Y. The typical form of the species is recorded from Ind. Pa. to Tex. Fla.

1699 *Metabletus americanus* (Dej.). Aug. 2, 1911, beneath bark of dying tamarack, VII; Sept. 12, 1920, sifted from damp leaves, X. (Det. H. C. Fall).

1700 *Axinopalpus biplagiatus* (Dej.). May 9, 1915, under bark of white pine log, XV.

1710 *Calleida punctata* Lec. Sept. 2, 1910, sweeping, VI, VIII.

1725 *Pinacodera limbata* (Dej.). Sept. 2, 1910, under bark on tamarack stump, VII. Ind. N. J. - Tex. Fla.

1726 *Pinacodera platicollis* (Say). Aug. 20, 1911, under bark of dying tamarack, VII; Sept. 2, 1910, under bark of tamarack sapling, VIII.

1752 *Cymindis americana* Dej. May 31, 1920, under bark on tamarack log (Wm. J. Gerhard), XII. Ind. N. J.

1817 *Chlaenius pennsylvanicus* Say. July 3, 1911, at light, II.

1856 *Anomoglossus emarginatus* (Say). May 9, 1915, five specimens, under sticks and logs, III, IX.

1922 *Harpalus faunus* Say. July 3, 1911, at light, II.

2009 *Harpalus vulpeculas* Say. Aug. 20, 1911, under bark of tamarack, X; Sept. 11, 1911, sifting sphagnum, XI; Sept.12, 1911, under log, II. Ind. Mo.

2132 *Anisotarsus sayi* Blatchley. Aug. 20, 1911, under loose bark of white pine tree, IV. Ind. N. Y. D. C.

2139 *Anisotarsus terminatus* (Say). June 17, 1916. "Tamarack swamp" (Dr. Wells).

2213 *Acupalpus carus* (Lec.). May 31, 1920, under bark of dead white pine, XII; Sept. 26, 1920, sifted from damp leaves, X; Sept. 2, 1925; sifting leaves and debris. Ia. R. I. - Can.

2218 *Stenolophus ochropezus* (Say). July 3, 1911, at light, II.

2220 *Stenolophus fuliginosus* Dej. Sept. 2, 1910, sweeping XIV. Ind. Pa. R. I. - Nfld.

2238 *Stenolophus conjunctus* (Say). June 17, 1916, "Tamarack swamp" (Dr. Wells).

HALIPLIDAE

2337 *Peltodytes edentulus* (Lec.). Taken with the following species.

HYDROPHILIDAE

*2740 *Helophorus inquinatus* Mann. July 3, 1911, at collecting light, II. This species seems to have been taken at on other place in this region. Sherman (1910) writes as follows concerning this species: "Ungava Bay (Turner: Schwartz list.) Mr. Schwart states that these are not to be considered definite determinations, as the genus requires investigation. . . . H. *Inquinatus* Mannh., is recorded from Alaska and Lake Superior." Bowditch (1896) records it from Summitt of Mount Washington, N. H.; Hamilton (1894) gives "Sitkha, Lake Superior; var. *consimilis* Mann. . . . Fort Constantine (Chtogaluk). Various places on Kenai."

2795 *Hydrophilus obtusatus* Say. July 3, 1911, five specimens taken with the preceding species. Have taken in many years collecting but one other specimen of this species it is labelled, "Mineral Springs, Ind. Oct. 6, 1911," but it does not carry a label showing it to have occurred in the swamp.

2836 *Enochrus perplexus* (Lec.). July 3, 1911, with the preceding species; May 31, 1920, three specimens dredged from small pool of water (about one foot in diameter) at base of white pine tree near center of swamp. Dredging in other pools even those at margin of quaking bog gave no results.

SILPHIDAE

2913 *Necrophorus orbicollis* Say. Aug. 20, 1911, under log, II.

2920 *Necrophorus tomentosus* Weber. Sept. 2, 1910, found clinging to a birch tree, II; Sept. 12, 1911, eight specimens, Sept. 15, one specimen, and Sept. 16, two specimens, attracted to carrion bait (blue-racers, *Zamenis constrictor* Linn.) killed and laid out for this purpose, Sept. 11, XII.

2922 *Silpha surinamensis* Fab. Sept. 16, 1911, taken at carrion bait mentioned above.

3014 *Colenis impunctata* Lec. Sept. 4, 1925, two specimens taken from under side of puffball.

SCYDMAENIDAE

—— *Connophron* sp. Sept. 3, 1925, four specimens, sifting leaves and debris.

ORTHOPERIDAE

3230 *Corylophodes marginicollis* (Lec.) Sept. 2, 1910, sweeping vegetation, VII, (W. J. Gerhard). Ind. R. I. - Fla.

3269 *Molamba ornata* Csy. May 31, 1920, sifted from sphagnum moss, XI. Ind. Ia.

STAPHYLINIDAE

3625 *Bledius fumatus* Lec. July 4, 1913, sweeping, X. Ind. Fla.

—— *Bledius* sp. near 3598-3687 ("Seems not to fit any described"—H. C. Fall), July 4, 1910, sweeping, X.

—— *Stenus* sp. near 3710-3856. (Det. H. C. Fall), Sept. 2, 1910, sifted from sphagnum, X.

3892 *Palaminus testaceus* Er. Aug. 20, 1911, under bark of dying tamarack, VII; Sept. 10, 1911, under bark of dead white pine, III; Sept. 14, 1911, sweeping, XII. Ia. D. C. - Miss.

3949 *Paederus palustris* Aust. July 3, 1911, at light, (Det. H. C. Fall); July 4, 1911, two specimens, sweeping, XI; July 30, 1911, three specimens sweeping and under bark, I, XI. Ind. Ia.

3950 *Paederus obliteratus* Lec. Sept. 1, 1925, sweeping in center of swamp. Ind. N. Y. Fla.

3952 *Paederus littorarius* Grav. July 4, 1911, two specimens, sweeping, VIII, XIV; Sept. 11, 1911, sweeping, two specimens, X, XI.

—— *Lathrobium* sp. Sept. 3, 1925, two specimens sifting leaves and debris.

—— *Lathrobium* sp. Sept. 3, 1925, sifting leaves and debris.

*3985 *Lathrobium simplex* Lec. May 31, 1920, taken from a large fleshy white fungus growing on the upper side of a pine log, XVIII; associated with *Philonthus lomatus, Eumicrota corruscula, Gyrophaena lobata* and *Scaphisoma impunctata*. L. Sup. Wis. Man.

4105 *Trachysectus confluentus* (Say). May 9, 1915, under bark of dead tamarack, V. Conn. R. I. Ind. Minn.

4265 *Astenus binotatus* (Say). July 4, 1916, "Open bog," near VII. (B. B. Fulton). Ind. Ia. Fla.

4272 *Astenus discopunctatus* (Say). Sept. 2, 1910, sweeping XIV. Ind. R. I. - Tex.

4285 *Nudobius cephalus* (Say). July 30, 1911, under bark of dying tamarack tree, X; Sept. 10, 1911, under bark of white pine tree, III. (Det. by H. C. Fall).

*4331 *Stictolinus scolopaceus* Csy. July 30, 1911, under bark of tamarack log, XIV; Sept. 2, 1910, sifting sphagnum moss, XXIV. (Det. by H. C. Fall). Wis. Mass.

—— *Diochus* sp. near 4358. Sept. 2, 1910, sifting sphagnum moss, XI, "May be Casey's *thoracicus*, described from Long Island, and may be no more than a variety of *schaumi*. I think your species is distinct from '*schaumi*' " (H. C. Fall in litt.).

—— *Actobius* sp. Near 4383. Sept. 5, 1920, two specimens, sifted from moist leaves and debris, II. Near *parcus* Horn but very distinct in sculpture and confused rows of thoracic punctures.

*4424 *Philonthus discoideus* (Grav.). July 30, 1911, under bark of log, I; Sept. 2, 1910, sweeping vegetation at bog margin, VII. (Det. H. C. Fall). Cosmop.

4443 *Philonthus lomatus* Er. Taken with *Lathrobium simplex*, above.

4443? *Philonthus lomatus* Er. ? Sept. 11, 1911, sifting sphagnum moss, X. "Apparently a variation or aberration of the common ofrm, with the posterior dorsal puncture of the pronotum more distant." (Fall in litt.).

—— *Philonthus* sp. near *cunctans* Horn. Aug. 15, 1920, sifted from leaves beneath a log, II.

*4445 *Philonthus aequalis* Horn. Aug. 15, 1920, taken in woodchuck excrement, XXIII. D. C. (type locality). Can. L. Sup.

4446 *Philonthus brunneus* (Grav.). Aug. 15, 1920, two specimens, sifted from leaves under log, II.

4447 *Philonthus cyanipennis* (Fab.). Oct. 10,1920, partly decayed toadstools, III.

4532 *Staphylinus vulpinus* Nordm. Sept. 16, 1911, seen to alight and crawl under decaying leaves in trail, X.

4546 *Staphylinus violaceus* Grav. Sept. 5, 1920, under bark of tamarack stump, X; Sept. 1, and 2, 1925, three specimens, under bark of decaying tamarack logs and stumps.

4552 *Ontholestes cingulatus* (Grav.). July 30, 1911, under mass of soft white fungi on base of tamarack log, XIII; Sept. 16, 1911, carrion bait, (dead blue-racer), XII; Aug. 15, 1920, two specimens beneath woodchuck excrement, II; May 4, 1912, three specimens, "Birch-Maple zone on ground," (V. E. Shelford).

4555b *Creophilus maxillosus* (L.) var. *villosus* (Grav.). Sept. 16, 1911, at carrion bait mentioned under No. 2920, above.

4579 *Quedius molochinus* (Grav.). Sept. 11, 1911, sifting sphagnum moss, X. (Det. H. C. Fall). Although recorded from all parts of North America north of Mexico, from all Europe, Caucasia and Siberia, Casey has written (1915, Mem. VI.), "*Molschinus* Grav., is more essentially surarctic in range, both in the Palaearctic and Nearctic faunae and the numerous American examples at hand from Rhode Island to Minnesota and southward in the Atlantic regions to southern Pines, North Carolina." Notman has written (in litt.), "*Q. molochinus* appears to be distinctly sub-arctic in its distribution. I have a specimen taken at about 2500 feet elevation. It is rather abundant from 4000 feet to 4500 feet and would probably be found up to limit of the trees at at 5000 feet. (Adirondack Mts.)"

*4628 *Oxyporus femoralis* Grav. Oct. 10, 1920, taken from a large clump of partly decayed toadstools, their heads 5-8 inches broad, stems finely carinate and al-

ways curving or somewhat contorted, III. Associated with *Philonthus cyanipennis*. O. N. J. D. C.

4634 *Oxyporus vittatus* Grav. Sept. 14, 1911, two specimens (♂ - ♀), in mass of fleshy white fungi, II.

*4668 *Tachinus limbatus* Melsh. July 4, 1911, sweeping vegetation along trail, XII. M. St. Conn. O.

4679 *Tachyporus elegans* Horn. July 4, 1911, sweeping vegetation, XI. Ind. Can.

4680 *Tachyporus pulchrus* Blatchley. July 30, 1911, Two specimens, under bark of tamarack sapling, VII. (Det. H. C. Fall). Known only from Ind.

—— *Leucoparyphus* sp. near 4687. Aug. 15, 1920, sifted from damp leaves, II.

4707 *Conosoma crassa* (Grav.). July 30, 1911, two specimens, under bark of tamarack logs, VIII, IX.

4727 *Bolitobius trinotatus* Erich. Sept. 26, 1920, taken in a large, fleshy yellowish fungus (toadstool shaped and about five inches in diameter) which was in an advanced stage of decomposition, XXIII.

4730 *Bolitobius cinctus* (Grav.). July 4, 1911, XII; Sept. 26, 1920, associated with the preceeding species. The specimen taken July 4 was collected by sweeping low plants—the species is found usually in fungi.

4742 *Mycetoporus americanus* Erichs. May 31, 1920, two specimens under fallen leaves, III, (Emil Liljebald). Ill. - Pa.

4947 *Eumicrota corruscula* (Er.). May 31, 1920, a large number of specimens associated with No. 3985, above. Ind. N. Y. - Tex.

4966 *Gyrophaena lobata* Csy. May 31, 1920, associated with, and fully as numerous as the preceding species. Ind. N. Y.

4995 *Gyrophaena fasciata* (Say). Sept. 10, 1911, three specimens, in fleshy white fungus, XI, (Determined by A. Fenyes as *Gryophaena vinula* (Dr.), which Leng (1920) lists as synonym of *G. fasciata.*) Ind. Pa. R. I.

—— *Hoplandria* sp. follows 5037. Taken with the preceding species. (Det. A. Fenyes).

—— *Atheta* sp. follows 5099. Taken with the preceding species. (Det. A. Fenyes).

—— *Atheta sp.* follows 5099. Aug. 20, 1911, under bark of dead tamarack tree, X; Sept. 2, 1910, sifted from sphagnum moss, X. (Det. A. Fenyes).

5614 *Pancota luteola* (Er.) Sept. 2, 1910, two specimens, sifting sphagnum moss, X; Sept. 5, 1920, sweeping, XIII. (Det. by A. Fenyes as *Atheta* (*Acrotona*) *luteola* Er.) Ind. Mich. Wis.

5751 *Aleodorus bilobatus* Say. May 9, 1915, sifting sphagnum moss, IX.

*5751 *Aleodorus canadensis* (Csy.). Sept. 2, 1925, sifting leaves and debris, Chapin writes (in litt., Oct. 18, 1932), "The specimen submitted agreed best with the type of *A. canadensis* Csy. The material available, as well as the time, is insufficient to undertake to determine the validity of the various species. The type specimens of *A. canadensis* were collected . . . at Ottawa, Ont., Canada . . . I do not know why Leng gives Que. as the locality."

*5813 *Baryodma verna* Say. Sept. 3, 1925, sifting leaves and debris. N. U. S. & Can.

5955 *Oxypoda palustris* Blatchley. Sept. 12, 1911, sifting sphagnum moss, IX. The type of this species was taken in Stark County, Indiana, not more than thirty or forty miles from Mineral Springs and was "sifted from sphagnum moss of a cranberry bog." Not recorded from elsewhere.

—— *Oxypoda* sp. near *palustris* Blat. Aug. 15, 1920, sweeping vegetation beneath tamaracks near bog margin, VII.

—— *Oxypoda* sp. Sept. 2, 1910, sifting sphagnum moss, I. (Det. A. Fenyes).

PSELAPHIDAE

*6133 *Ramecia arcuata* (Lec.). Oct. 10, 1920, XIII. This specimen was found on the white cloth while puff-balls (*Lycoperdon pyriforme*) were spread out for examination; it may have been gathered up with the fungi. Va. Ga. Fla.

—— *Rybaxis* sp. Follows 6309. July 4, 1911, sweeping in trail, X.

SCAPHIDIIDAE

6489 *Scaphisoma convexum* Say (?). Sept. 1, 1925, sweep-in maple zone.

*6494 *Scaphisoma impunctata* Reit. May 31, 1920, taken with *Lathrobium simplex* and others. See note under no. 3985. Mo. If *reoabda* Casey is a synonym also Ia. Mass.

HISTERIDAE

6606 *Hister depurator* Say. Sept. 16, 1911, six specimens taken from carrion bait mentioned under no. 2920, above.

6657 *Platysoma bassale* Lec. July 30, 1911, fourteen specimens and Aug. 20, 1911, four specimens, all taken beneath bark of dying white pine tree, VII; May 3, 1915, four specimens taken under bark of tamarack log in company with *Polygraphus rufipennis*, V. Ind. O. Mich.

6659 *Platysoma coarctatum* Lec. Aug. 20, 1911, three specimens taken with the preceeding species of this date; associated with these two species were *Metabletus americanus* Dej., *Cossomus corticola* Say,

Plegarderus transversus Say, *Ips calligraphus* Germ., and *Ips grandicollis* Eich. May 30, 1910, "Pine-Tamarack Zone. Sweeping beneath medium Tamaracks" (E. V. Shelford); May 9, 1915, two specimens under bark on dead pine tree, V.

6765 *Plegaderus transversus* Say. July 30, 1911, five specimens under bark on dying white pine trees, IV; Sept. 10, 1911, two specimens under bark on dead white pine tree, III.

6781 *Acritus politus* (Lec.). May 31, 1920, under bark of pine log, III.

6819 *Saprinus posthumus* Mars. July 4, 1911, in fleshy fungus growing on tamarack, XI; (Det. by J. D. Hood), Aug. 15, 1920, beneath woodchuck excrement, XXIII.

6885 *Saprinus fraternus* Say. Sept. 11, 1911, sifting sphagnum moss, VIII.

LYCIDAE

6926 *Calopteron reticulatum* (Fab.). May 20,1921, sweeping, X.

6945 *Plateros modestus* (Say). July 3, 1911, at light, II; Aug. 15, 1920, sweeping, XVI.

LAMPYRIDAE

6971 *Lucidota atra* (Fab.). July 4, 1911,sweeping, XIII.

6975 *Lucidota corrusca* (Linn.) Sept. 2, 1910, three specimens, XIV; May 3, 1921, "shrub in Birch-Maple Zone" (E. V. Shelford); May 31, 1920, two specimens, sweeping, VI (W. J. Gerhard) and beating dead tamarack branches near middle of swamp (Emil Liljeblad); April 24, 1921, on maple tree, in evening, X.

6975a *Lucidota corrusca* (Linn.) var. *autumnalis* (Melsh.). May 9, 1915, two specimens on trunks of maple trees, II.

6975b *Lucidota corrusca* (Linn.) var. *lacustris* (Lec.)? Sept. 1-4, 1925, forty-three specimens, sweeping in all parts of swamp and on quaking bog. Ind. L. Sup. Hudson Bay.

6984 *Pyractomena angulata* (Say). Sept. 2, 1910, sweeping, IV.

6996 *Photinus pyralis* (Linn.). July 3, 1911, two specimens at light, II. Ill. Pa. - Tex.

7013 *Photuris pennsylvanica* (Deg.) July 3, 1911, two specimens taken with nos. 6996 and 6945, above; Sept. 2, 1910, two specimens on trunks of white pine tree, XIII, XIV.

CANTHARIDAE

7055 *Podabrus tricostatus* (Say). July 12, 1921, specimen dead and being pulled along in trail by a large black ant, X; April 24, 1921, at rest on tree trunks, X. Ind. Pa. Can.

7098 *Cantharis lineola* Fab. July 30,1911, two specimens, sweeping, VII; Aug. 15, 1920, many seen in tamaracks, especially near margin, VII; May 31, 1910, two specimens, "Sweeping vegetation over open bog" (E. V. Shelford).

7137 *Polemius laticornis* (Say). Aug. 15, 1920, two specimens sweeping, XX. Ill. Conn. - Tex. Fla.

7162 *Silis latiobus* (Blatch.). May 9, 1912, sweeping, XV. Described (as a *Ditemmus*) from Lake, Marion, Putnam, Vigo and Crawford counties, Indiana, but Van Dyke has since recorded it from Minn. Ia. Nebr. and Mo., remarking tha,t "It seems to be common in Missouri.

MELYRIDAE

7227 *Collops quadrimaculatus* (Fab.). July 4, 1911, three specimens, VII, XVI; Sept. 11, 1911, III; all taken by sweeping.

7282 *Pseudebaeus oblitus* (Lec.). July 4, 1910, sweeping at bog margin, XVI.

7294 *Attalus terminalis* (Erichs.). July 30, 1911, sweeping, X.

CLERIDAE

7585 *Thanasimus dubius* (Fab.). Aug. 20, 1911, three specimens, and Sept. 3, 1911, two specimens, all taken on the same large white pine tree, III. They were all on the sunny side of the tree, running about seeking entrance to a Scolytid beetle burrow, presumably that of *Ips calligraphus*, judging from the manner in which the frass was thrown out with the exuding pitch. None of them, however, were observed in the act of feeding. "Occurs with *Polygraphus rufipennis* and *Dendroctonus simplex* on partially dead tamaracks, also as larva in same situation, Sept. 9, 1909," (V. E. Shelford).

7594 *Enoclerus nigrifrons* (Say). June 12, 1921, taken flying about large fallen tamarack tree, V.

7596 *Enoclerus nigripes* (Say). June 12, 1921, three specimens beaten from uppermost branches of large fallen tamarack tree, V.

7675 *Hydnocera verticalis* (Say). July 4, 1911, sweeping, XI.

7694 *Zenodosus sanguineus* (Say). Sept. 11, 1911, found by Mrs. Wolcott upon her neck, while standing beneath a large Scolytid—infested white pine, III.

7696 *Phyllobaenus dislocatus* (Say). Aug. 20, 1911, dead specimen under bark of tamarack log, VI; June 12, 1921, beaten from upper branches of fallen tamarack, V.

—— *Clerid* larva sp? follows 7696. Several specimens, July 30, 1911; a few specimens, Aug. 20, 1911; all taken in galleries of *Ips calligraphus* in a dying white pine, III.

MORDELLIDAE

7811 *Mordella scutellaris* Fab. July 30, 1911, sweeping, XIII, (Det. E. Liljeblad).

*7862 *Mordellistena tosta* Lec. Aug. 15, 1920, sweeping XV. (Det. E. Lilijeblad). Ariz. So. Cal. N. Y. Ga. O. Fla.

7872b *Mordellistena ustulata* Lec. Aug. 15, 1920, seen to alight upon the page of an open book in my hands, II. (Det. E. Liljeblad).

MELOIDAE

8042 *Macrobasis unicolor* (Kirby). July 4, 1911, found on goldenrod (*Solidago canadensis* Linn. Det. by Dr. J. M. Greenman), near bog-margin.

PYROCHROIDAE

8220 *Neopyrochroa flabellata* (Fab.). July 3, 1911, at light, II.

ANTHICIDAE

8304 *Notoxus monodon* Fab. Sept. 2, 1910, sweeping, XI, XIV; Sept. 12, 1920, four specimens sifted from damp leaves and sphagnum moss, X.

*8340 *Amblyderus granularis* (Lec). Sept. 4, 1911, VII, (Det. H. C. Fall). The single specimen taken in the swamp was probably a straggler from the beach of Lage Michigan, where it was not at all uncommon in September, a total of 36 specimens having been taken on six days. Almost all of these were taken before 7 a. m., (the species disappearing entirely a little later in the day and reappearing in the evening) ; two specimens were found early in the morning in the washup, the others under light pieces of shelter, when uncovered they quickly begin to burrow into the sand. This species appears (like *A. pallens*) to be a true dweller of lake beaches. Its rarity in collections would seem to be due to the fact that its season of greatest abundance is at a time when most collectors have closed operations for the year.

The conditions under which the specimens were taken would indicate that the species is nocturnal. Were this a truly boreal species its appearance upon the beach should be as a vernal species (Adam's criterion 5, p. 184, Isle Royal Surv. 1908) and it would be expected to occur later in the year in the swamp; however the most careful search in the swamp from Sept. 3 to 16 failed to produce another individual. It is evidently a member of a small, but widely dispersed biota—the sub-maritime. It is described from Lake Superior but has been taken also in N. Y. and Mass. (F. Blanchard in litt.) Mich. (Hubbard and Schwartz) and Colo. (Snow).

8454 *Anthicus pubescens* LaFerte. Sept. 2, 1910, sweeping, VIII. (Det. H. C. Fall). R. I. - Ia.

ELATERIDAE

8561 *Adelocera discoidea* (Web.). July 4, 1911, sweeping in western part of swamp.

8562 *Adelocera avita* (Say). July 4, 1913, under bark of dead tamarack tree, VI.

8571 *Alaus oculatus* (Linn.). Sept. 4, 1925, fragments of one beetle in decaying tamarack log. Ind. Atl. St. - Tex. Fla.

8572 *Alaus myops* (Fab.). Sept. 1, 1925, under bark of decaying tamarack log in eastern portion of swamp.

8633 *Limonius quercinus* (Say.). May 31, 1920, on ferns, XX.

8715 *Ludius pyrrhos* (Hbst.). July 3, 1911, three specimens at light, III; July 4, 1911, sweeping, XII; Aug. 15, 1920, sweeping, XI.

8748 *Ludius sulcicollis* (Say). July 4, 1914, two specimens at rest on trunk of a tamarack tree, XV.

8796 *Ludius hieroglyphicus* (Say). July 3, 1911, at light, II. Ind. O. —L. Sup. Me.

8861 *Parallelostethus attenuatus* (Say.). July 4, 1913, sweeping, X; Aug. 15, 1920, while seated upon a grassy spot (IV)a loud buzzing sound was heard about my head and the next instant a female specimen of this species alighted upon my knee; this was no sooner bottled than I saw another flying from the swamp, this specimen, a male, also alighted upon my knee, landing in just the same spot as that upon which the female had come to rest. The female was hidden from view so that the male was guided in its pursuit by another sense than that of sight.

8878 *Dolopius lateralis* Esch. July 31, 1920, twelve specimens beaten from top limbs of dead uprooted tamarack trees, VI.

8943 *Elater rubricus* Say. July 4, 1910, sweeping, I, VII; May 31, 1920, under bark of dead tamarack, V, (Emil Liljeblad).

8956 *Elater pusio* Germ. Sept. 1, 1925, sweeping in maple zone. Ind. Ill. - Ga.

8960 *Elater pedalis* Germ. July 3, 1911, at light, II.

*8983 *Megapenthes rufilabris* (Germ.). July 4, 1911, two specimens by sweeping, XI. (Det. H. F. Wickham). M. & S. St.

9024 *Melanotus blatchleyi* Leng. Sept. 5, 1920, on elderberry (*Sambucus canadensis*), II. Known only from Ind.

9035 *Melanotus communis* (Gyll.). July 3, 1911, at light, II; July 4, 1911, sweeping, XII; Sept. 2, 1910, under bark of tamarack stump, I; Aug. 4, 1912, "tamarack swamp, forest, on herbs" (V. E. Shelford); May 9, 1915, under bark of pine stump, X; May 31, 1920, five specimens, one under bark of pine stump, three under bark of tamarack stump and one beaten from dead alder, V; Sept. 1, 3, 1925, three specimens in decaying tamarack logs.

9036 *Melanotus fissilis* (Say). May 9,1925, under bark of dead tamarack tree, XVI.

9059 *Melanotus sagittarius* (Lec.). July 3, 1911, two specimens at light, II; (Det. H. C. Fall), July 4, 1913, sweeping, I.

9087 *Cardiophorus gagates* Erich. July 4, 1911, on trunk of white pine, VI.

*9092 *Cardiophorus convexulus* Lec. May 31, 1920, two specimens under bark on dead pine, XI. O. N. Eng. Can.

MELASIDAE

9127 *Isorhipis ruficornis* (Say). July 3, 1911, at light, II.

THROSCIDAE

9204 *Throscus chevrolati* Bonv. July 3, 1911, at light, XII.

BUPRESTIDAE

9272 *Acmaeodera pulchella* (Hbst.). July 4, 1911, sweeping, I. In this specimen the yellow spots before the hind angles of the prothorax are entirely wanting. Ind.Pa. south and west to Fla. and Cal.

9333 *Dicerca divaricata* (Say). July 3, 1911, on trunk of birch tree, II; July 4, 1911, seven specimens, two on same tree as above, others sweeping, III, XI; Sept. 10, 1911, sweeping, III.

*9346 var. *Dicerca chrysea* Melsh. var. *bifoveata* Lec. Aug. 15, 1920, a dead and disintegrated specimen dug from badly decayed log, XII, (Mr. Jones). Casey evidently regards *bifoveata* as a subspecies of *chrysea* but he records *bifoveata* as occurring at "Lake Superior (south shore) from Duluth to White Fish Point" and gives *tenebrosa* Lec., as a synonym. I have specimens of the typical form from Duluth which were formerly determined as *tenebrosa* but which were submitted to Mr. C. A. Frost, a recognized authority in Buprestidae and determined by him as "*chrysea* Mels. sp. vera." Both forms are

thus shown to occur at Duluth and while *bifoveata* is recognizable as a variety, I doubt if it can be considered a subspecies in view of the fact that both forms occur in the same locality. "*Bifoveata* . . . is strictly a northern form. The species of *Dicerca* are very badly confused and *bifoveata* and *chrysea* may prove to be distinct species if a careful study could be made of a large series," W. S. Fisher, in litt.

9363 *Buprestis striata* Fab. July 4, 1913, dug from living tamarack tree, VIII.

9370 *Buprestis maculativentris* Say. June 24, 1916, "Weeds edge of woods" (B. B. Fulton).

*9372a *Buprestis nuttali* (Kby.) var. *consularis* Gory. June 26, 1921, two specimens on trunk of large fallen dead tamarack tree, V.

9389 *Melanophila notata* Lap. & Gory. June 12, 1921, five specimens at rest on trunk of large fallen tamarack tree, on spots from which the writer had previously removed the bark, V.

9578 *Taphrocerus gracilis* (Say). Sept. 2, 1910, XIV; Sept. 10, 1911, XII; Sept. 12, 1920, XII, all taken by sweeping.

HELODIDAE

9696 *Cyphon obscurus* (Guer.). July 3, 1911, two specimens at light, II; July 4, 1911, sweeping, I.

9698 *Cyphon variabilis* (Thunb.). May 30, 1910, "tamarack forest, — sweeping undergrowth beneath medium size tamaracks," (V. E. Shelford); July 4, 1910, sweeping, IX; July 30, 1911, six specimens, four taken in sifting sphagnum moss, II, X, and two by sweeping, XIII; Sept. 2, 1910, eight specimens, six taken in sifting sphagnum, II, VII, XI, and two by sweeping, VII; Aug. 15, 1920, three specimens, two of which were the dark form, XI; Sept. 12, and 26, 1920, sifting damp leaves, X; Sept. 1-2, 1925, nine specimens, sweeping in maple zone.

9699 *Cyphon padi* (Linn.). July 30, 1911, two specimens sifted from sphagnum moss, XI, two taken by sweeping, VII; Sept. 2, 1910, five specimens sifted from spagnum, X, VIII, and one taken by sweeping, XIV; May 4, 1912, "Birch-Maple Zone,—shrubs" May 30, 1910, "Tamarack forest, sweeping medium tamaracks" (V. E. Shelford); Aug. 15, 1920, taken in numbers by sweeping throughout the swamp, but most abundant near quaking bog; VII, Sept. 1-3, 1925, 19 specimens, sweeping in maple zone and on quaking bog.

9700 *Cyphon americanus* Pic. July 4, 1916, two taken on "plants in woods," two on "bog" (B. B. Fulton); Sept. 12, 1910, three sifted from leaves and debris, X; Oct. 10, 1920, two specimens sifted from sphagnum moss, V. These specimens were first considered as an undescribed species because the elytral depressions were much paler in color than the elytra in general, but comparison with Florida specimens sent me by Prof. W. S. Blatchley showns them to be the same species. This species was described from Florida and we find no records of its occurrence elsewhere.

9708 *Scirtes tibialis* Guer. July 3, 1911, three specimens taken at light, II; July 4, 1911, sweeping, XIII.

DERMESTIDAE

9805 *Cryptorhopalum haemorrhoidale*, J. E. Lec. "zone older tamaracks, Tamaracks dead. Beaten from undergrowth" (V. E. Shelford). Ind. No. Kans. - Tex. Fla.

9825 *Cryptorhopalum picicorne* Lec. Sept. 2, 1910, sweeping, VII. Ind. - Mass.

OSTOMIDAE

9991 *Tenebroides laticollis* Horn. July 3, 1911, at light, II. Ind. south and west to S. St. and Ut.

—— *Tenebroides laticollis* Horn var. *obscurus* Horn. July 4, 1911, sweeping, XIV.

NITIDULIDAE

10058 *Carpophilus brachypterus* (Say). Sept. 11, 1911, V; May 31, 1920, VI. Both were beaten from the top branches of fallen dead tamaracks; Sept. 1, 1925, sweeping on quaking bog.

10098 *Stelidota geminata* (Say). Sept. 5, 1920, two specimens found clinging to a decaying banana peeling, II. Both specimens remained at rest for several minutes after being exposed to view, but were quite active afterward.

10129 *Cryptarcha ampla* Er. July 30, 1911, under bark of tamarack tree, XI.

10138 *Glischrochilus sanguinolentus* (Oliv.). April 24, 1921, three specimens taken in late evening on maple tree trunk, feeding at small spot of exuding sap, X.

CUCUJIDAE

10200 *Silvanus imbellis* Lec. Sept. 4, 1925, two specimens, under bark of log. Ind. - Fla. So. Cal.

10211 *Catogenus rufus* (Fab.). Aug. 20, 1911, under bark of dead tamarack, VIII; Sept. 3, 1925, under bark of decaying tamarack log.

*10242 *Laemophloeus modestus* (Say). May 31, 1920, beaten from maple branch, V. (Emil Liljeblad). D. C. - Fla. Tex. (Casey). Can. Ga. (Blatchley).

10276 *Telephanus velox* Hald. July 4, 1911, XIII; Aug. 20, 1911, VII, Sept. 15, 1911, four specimens, III; Sept. 16, 1911, two specimens, VII. Most of these were taken by sweeping low vegetation.

EROTYLIDAE

10292 *Acropteroxys gracilis* Newm. "May, forest margin, bog side, on shrubs" (V. E. Shelford); July 9, 1916, "surface of bog" (B. B. Fulton). The head of the latter specimen is entirely black, as in *lecontei* Crotch.

CRYPTOPHAGIDAE

10365 *Tomarus pulchellus* Lec. Sept. 2, 1910, sifting sphagnum moss, XII; Sept. 26, 1920, twelve specimens taken by sweeping, X; Sept. 5, 1920, sweeping, III.

10384 *Cryptophagus acutangulus* Gyll. Sept. 26, 1920, in a large yellowish, decayed toadstool, XXII.

—— *Atomaria* sp. Sept. 3, 1925, sweeping in maple zone.

10463 *Anchicera ephippiata* Zimm. Aug. 15, 1920, sweeping, IX.

MYCETOPHAGIDAE

10517 *Litargus didesmus* Say. Sept. 2, 1910, in fleshy white fungus growing on tamarack log, XII. (Det. F. C. Fall).

COLYDIIDAE

10604 *Philothermus glabriculus* Lec. Aug. 20, 1911, under bark of dying tamarack, VIII; Sept. 5, 1920, two specimens, under bark of pine and tamarack stumps, X.

LATHRIDIIDAE

10631 *Lathridius liratus* Lec. July 30, 1911, three specimens taken by sweeping, IX; (Det. H. C. Fall) Sept. 2, 1910, sifted from sphagnum, X; May 31, 1920, two specimens beaten from branches of maple tree, IV, and from branches of dead tamarack tree, V; Aug. 15, 1920, found abundant throughout the swamp by sweeping; Sept. 5, 1920, sweeping in evening—quite dark owing to an approaching storm, XII-XIII; Sept. 1, 1925, sweeping in maple zone.

10642 *Enicmus minutus* (Linn.). Aug. 15, 1920, found throughout tamarack forest, but especially abundant near bog margin (VII).

10694 *Corticaria ferruginea* Marsh. Sept. 2, 1925, under bark of log.

10696 *Melanophthalma picta* Lec. Sept. 1, 1925, sweeping on quaking bog.

10701 *Melanophthalma distinguenda* Com. July 30, 1911, four specimens by sweeping, VII-VIII; (Det. H. C. Fall), Sept. 2, 1910, sifted from sphagnum, X; Aug. 15, 1920, common throughout swamp; Sept. 5, 1920, XII; Sept. 1-3, 1925, 13 specimens, many taken by sweeping in maple zone, a few by sweeping among tamaracks and on quaking bog, one sifting leaves and debris. .

10705 *Melanophthalma gibbosa* Hbst. Sept. 5, 1920; Sept. 26, 1920, four specimens; all taken by sweeping herbage, X.

10712 *Melanophthalma americana* Mann. Sept. 3, 1925, sweeping in maple zone.

ENDOMYCHIDAE

10720 *Lycoperdina ferruginea* Lec. Oct. 10, 1920, many specimens taken in the fungus *Lycoperdon pyriforme* Schaeff., XII, XIII. These insects simulate death to a remarkable degree; upon removal from the host plant they were laid in various positions upon a white cloth, none made any movement for more than five minutes. However, no attempt was made during this time to remove the fungi spores from their bodies and the spores do well conceal the beetles. One pair was removed in copula and remained so even after being placed in the cyanide jar. The larvae, which were mostly half-grown, form a sort of pupal cell of loosely webbed spores.

PHALACRIDAE

10773 *Phalacrus politus* Melsh. July 30, 1911, sweeping, XVII.

*10776 *Olibrus vittatus* Lec. July 30, 1911, sweeping, X. (Det. by Professor Fall as *O. nigricollis* which is considered as a synonym of *vittatus* by both Casey and Lang.)

10780 *Olibrus semistriatus* Lec. July 30, 1911, three specimens taken by sweeping, IV; Sept. 1-2, 1925, two

specimens, sweeping in maple zone and on quaking bog.

COCCINELLIDAE

10879 *Hyperaspis signata* (Oliv.). Aug. 15, 1920, XVI. Sept. 5, 1920, XV; both taken by sweeping, as were all other specimens of this family except as noted otherwise.

10908 *Hyperaspis fimbriolata* Melsh. July 4, 1911, VII.

10930 *Hyperaspis undulata* (Say). July 4, 1911, a male, found on a fern, I.

—— *Scymnus* sp. Sept. 1, 1925, sweeping in maple zone.

11018 *Scymnus cervicalis* Muls. July 4, 1913, VII.

11024 *Scymnus caudalis* Lec. July 4, 1913, II.

11028 *Scymnus collaris* Melsh. Aug. 20, 1911, VII; Sept. 16, 1911, three specimens, VII.

11035 *Scymnus puncticollis* Lec. Sept. 16, 1911, VII. This may not be distinct from *S. collaris* with which it occurred this date, two of the three specimens of *collaris* have the femora in great part piceous. Ind. Conn.

*11079 *Scymnus nanus* Lec. Sept. 5, 1920, III. Mich. Fla. So. Cal Ariz.

11147 *Coccidula lepida* Lec. May 4, 1912, "Old stage tamarack decay" (V. E. Shelford). Ind. Pa. Conn. - Can.

11150 *Psyllobora viginti-maculata* (Say). July 4, 1911, VIII; July 30, 1911, two specimens, XII; Sept. 11, 1911, X; May 9, 1915; under shelter, I; Sept. 5, 1920, IV; Sept. 1, 1925, seven specimens, sweeping on quaking bog.

11158 *Ceratomegilla fuscilabris* (Muls.). Sept. 11, 1911, I.

11162 *Hippodamia tibialis* (Say). July 4, 1911, IV; Aug. 15, 1920, XII. The authors have followed Timberlake (1919) in considering the North American species as distinct from the European *13 - punctata.*

11173 *Hippodamia novemnotata* Hbst. July 4, 1911, eight specimens, I-XI; Sept. 10, 1911, II.

11189 *Cycloneda sanguinea* (Linn.). July 4, 1911, VII, XI.

11190 *Cycloneda munda* (Say). Sept. 1, 1925, two specimens, sweeping on quaking bog.

11202 *Anatis quindecimpunctata* (Oliv.). July 30, 1911, at rest on trunk of tamarack tree, XI.

ALLECULIDAE

11250 *Hymenorus melsheimeri* Csy. July 3, 1911, three specimens at light, II; May 31, 1920, a pupa under bark of tamarack stump, VIII; this pupa transformed to adult June 10, 1920. Ind. Mich.

11267 *Hymenorus discretus* Csy. July 3, 1911, at light, II.

11269 *Hymenorus densus* Lec. July 3, 1911, taken with two preceding species. Ind. O. - Tex. Fla.

11311 *Isomira quadristriata* Couper. July 3, 1911, four specimens taken with the preceding species. (Det. H. C. Fall).

TENEBRIONIDAE

12305 *Diaperis maculata* Oliv. Sept. 12, 1920, taken in the common shelving fungi, which was dead and brown, XIII. Some of the fungus containing larvae was brought to the laboratory and two adults emerged, Oct. 24, 1920.

12386 *Scotobates calcaratus* (Fab.). July 6, 1913, under bark of dead pine tree, VIII, Aug. 15, 1920, found dead, lying on upper surface of a badly decayed log which was entirely concealed by the luxuriant growth of ferns, XII. From the same log *Dicerca chrysea* var. *bifoveata* and *Pterostichus adoxus* were taken by Mr. Jones.

12389 *Merinus laevis* (Oliv.). July 3, 1911, at light, II.

12392 *Haplandrus fulvipes* (Hbst.). July 4, 1911, sifted from sphagnum moss, X.

12408 *Alobates barbata* (Knoch). Sept. 2, 1910, under bark of oak tree, III. Ind. and southward.

12414 *Tenebrio molitor* Linn. Sept. 4, 1925, in decaying tamarack log.

12415 *Tenebrio picipes* Hbst. July 30, 1911, under bark of tamarack tree, VII; Sept. 2, 1910, under bark of oak, III; May 31, 1920, three specimens in badly decayed tamarack stumps, VI.

12425 *Anaedus brunneus* (Ziegl.). Sept. 11, 1911, sifting sphagnum, I; Sept. 16, 1911, one specimen, sifting sphagnum, X; May 31, 1920, under damp leaves, II (W. J. Gerhard); Sept. 12, 1910, three specimens sifted from damp leaves, mosses and debris in north lobe of swamp. Blatchley (1910) says "frequent in sandy localities, beneath bark, logs, and stones." In twenty-five years collecting in this vicinity, I have never seen or found a specimen of this species excepting those taken in the swamp.

*12432 *Paratenetus punctatus* Spin. Sept. 2, 1910, sweeping low vegetation, XI, (W. J. Gerhard), (Det. verified by H. C. Fall); Sept. 12, 1920, sifted from damp leaves and debris, X. Differs from the species as described by having a broad but obscure median fascia on thorax and a common triangular maculation on scutellar region of the elytra. Sept. 1, 1925, two specimens, sifting leaves and debris. N. & C. Am.

12433 *Paratenetus fuscus* Lec. Sept. 12, 1920, four specimens taken with the preceding species. Ind. L. Sup.

12485 *Meracantha contracta* (Beauv.). July 30, 1911, both clinging to trunks of trees, III, XIII.

MELANDRYIDAE

12529 *Synchroa punctata* Newm. April 24, 1921, a specimen somewhat immature was taken late in the evening on trunk of maple tree, II.

12531 *Eustrophinus bicolor* (Fab.). July 30, 1911, on fleshy white fungus growing on base of tamarack log, XII.

12546 *Orchesia castanea* Melsh. Sept. 4, 1925, two specimens dead in cells in bark of tamarack log.

*12561 *Rushia longula* (Lec.). July 30, 1911, beneath bark of dying white pine tree, VIII, (W. J. Gerhard), under bark of dead tamarack, VII; July 6, 1913, under bark of fallen dead tamarack, V. Middle States (LeConte in original desc.). Fla. (Leng). The New Mexico record (Snow) is probably for what is now known as *R. brevicollis* Fall.

12570 *Dircaea quadrimculata* (Say). May 31, 1910, "Tamarack forest, under bark on tamarack" (V. E. Shelford).

*12579 *Anisoxya glaucula* Lec. ? var. May 9, 1915, a badly mutilated specimen, the head and most of the legs being missing, was found beneath bark of a tamarack sapling, VIII. The prothorax and body beneath is black, the elytra fulvous, the anterior and posterior tibiae dull fulvous (the middle one missing) whereas *glaucula* is described as fuscus, the body beneath, antennae and legs fusco-testaceous.

12580 *Allopoda lutea* (Hald.). May 30, 1910, "Sweeping undergrowth beneath tamaracks in Tamarack Forest." (V. E. Shelford). Ind. N. Y. Fla.

12588 *Canifa pallipes* (Melsh.). May 31, 1920, under bark of tamarack stump, central portion of swamp.

ANOBIIDAE

12855 *Caenocara oculata* (Say). Sept. 11, 1911, sweeping, II; Sept. 1, 1925, on puffball; Sept. 4, 1925, seven specimens in cells in ripe puffball, many larvae and pupae were present.

LYCTIDAE

12938 *Lyctus opaculus* Lec. June 12, 1921, on wild fox grapes, V.

SPHINDIDAE

*12952 *Eurysphindus hirtus* Lec. Sept. 1, 1925, sweeping. Previously known from Detroit, Mich., and Cincinnati, O.

SCARABAEIDAE

13048 *Canthon laevis* (Drury). July 3, 1911, at light, II.

13080 *Onthophagus hecate* Panz. Aug. 15, 1920, sweeping herbage, V.

13090 *Onthophagus tuberculifrons* Harold. Aug. 15, 1920, sixteen specimens, in and beneath woodchuck excrement, XXIII. Ind. N. Y. - Fla.

13119 *Aphodius fimetarius* (Linn.). May 9, 1915, horse dung, X.

13263 *Ochodaeus musculus* (Say). July 3, 1911, at light, II. (Det. H. C. Fall). Ind. Mich. - Kans. Man.

13296 *Geotrupes opacus* Hald. Oct. 28, 1916, two specimens in swamp—no further data obtained. (H. Stoddard).

13364 *Serica sericea* (Illig.). July 3, 1911, at light, II.

13501 *Phyllophaga prunina* (Lec.). July 3, 1911, two specimens at light, II. (Det. J. D. Hood).

13517 *Phyllophaga drakei* (Kirby). July 3, 1911, four specimens taken at same locality as preceding species, but appeared much earlier in evening. (Det. J. D. Hood).

13544 *Phyllophaga crenulata* (Froel.). July 3, 1911, two specimens taken with *P. prunina*. (Det. J. D. Hood).

13563 *Phyllophaga tristis* (Fab.). June 10, 1922, in mass of sphagnum moss, XXIV.

CERAMBYCIDAE

14081 *Derobrachus brunneus* (Forst.). July 3, 1911, at light, II; Sept. 10, 1911, dead at base of tamarack tree, XI. (W. J. Gerhard).

14099 *Smodicum cucujiforme* (Say). July 3, 1911, at light, II.

*14107 *Asemum moestum* Hald. May 9, 1915, two dead specimens under bark of white pine stump, XIV; May 31, 1920, two specimens under bark of tamarack stumps, XI. Casey gives Penn. Mass., but some very closely allied species (?) are recorded from Bayfield, Wis., and L. Sup.; the writer considers these as not more than varieties of *moestum*. Leng gives Alas. L. Sup. Mass. Fla.

14298 *Rhagium lineatum* Oliv. Sept. 10, 1911, nine adult specimens under bark of large dead white pine, III. When found they occupied flattened cells about one inch in diameter, in bark next to wood, the place of emergence being invariably at upper part of the cell. There were, by actual count, forty of these cells, most of them on northwest side of tree about six feet from surface of ground, although scattered cells were found from this point to the ground. Some of the specimens found were yet in the pupal stage, others freshly transformed and almost entirely pale, while others were apparently (not actually) fully developed; it is evident that these would not have emerged until the following year.

*14441 *Brachyleptura vagans* (Oliv.). July 30, 1911, five dead specimens found in burrows in dead tamarack tree about six inches in diameter, VII. The specimens were extremely variable in color. The bores in which they were found were not entirely in the wood, but also part way through the bark. The bores were all five and one-half to six feet above surface of swamp. Burrows, supposed to be those of young larvae of this species were found in near-by tamaracks. July 6, 1913, many specimens on Spirea blossoms, just north of IV. Several pairs were observed *in copula*. This species has not been recorded as inhabiting tamarack so far as known to the authors. Felt (1905-1906) says, "a single specimen of this small longicorn was taken on scrub oak," and adds, "recorded from a number of New Jersey lo-

calities by Dr. Smith, who states that it has been bred from butternut, hickory and birch." The form *cuneatula* Casey occurred in nearly equal numbers on both dates with typical *vagans*, but I doubt that it is a distinct species. I possess a typical specimen of *cuneatula* taken with the type material at Bayfield by Professor Wickham. Can. - Ga.

14469 *Strangalepta vittata* (Oliv.). July 4, 1910, under bark of dead tamarack, XI; July 6, 1913, many specimens with the preceding species, July 10, 1922, a pair *in copula* on a blossom, IV.

14857 *Batyleoma suturale* (Say). July 4, 1911, sweeping, II; July 30, 1911, on blossom of *Solidago canadensis*, VII.

14901 *Monochamus notatus* (Drury). July 4, 1911, clinging to trunk of yellow birch tree, II; (Det. H. C. Fall). This specimen is very small (17 mm.) agreeing in size with *M. carolinensis*, and the elytra especially as apices are somewhat deformed, but the uniformly pubescent antennal joints leave no doubt as to the correctness of the determination. Sept. 10, 1911, a freshly transformed adult of normal size found at base of *Rhagium* infested dead white pine from which the bark had just been removed, III (W. J. Gerhard). Sept. 12, 1920, three specimens, and Sept. 26, 1920, two specimens, XII, on a recently uprooted living white pine tree, but had apparently come from a dead or dying small white pine which had been carried down by the large tree. The small tree (about six inches in diameter) contained numerous boring in the region between ten and twenty-five feet from the roots and the "sawyers" could be plainly heard at work. Larvae (12-27 mm.) were taken from this tree, on which the bark was thin. Search failed to produce any associated insects. Felt (1905-1906) says, "This insect which appears to have a general distribution in pine, spruce, and balsam distribution, ranges from West Virginia into

Canada, and according to published accounts, it appears to be much more abundant to the north."

14904 *Monochamus scutellatus* Say. June 12, 1921, four specimens, taken on the trunk of a large, fallen white pine (same as that upon which *M. notatus* was taken Sept. 20, 1920), XII. Ind. Wis. Me. - Hudson Bay, Calif?

14960 *Astylopsis macula* (Say). July 4, 1911, sweeping, X.

14968 *Leiopus variegatus* (Hald.). July 4, 1913, at rest on trunk of pine tree, VIII.

14979 *Leiopus vicinus* (Hald.). July 4, 1911, sweeping, I. Ind. - - N. Y. N. J.

15119 *Saperda lateralis* Fab. July 4, 1911, sweeping, XV. (W. J. Gerhard).

15138 *Oberea tripunctata* (Swed.). July 4, 1911, two specimens by sweeping, IX. Not typical, the head being pale and the body beneath almost wholly black.

15148 *Oberea bimaculata* (Oliv.). Sept. 2, 1910, sweeping, VI. Ind. Conn.

15152 *Oberea ocellata* Hald. July 4, 1911, three specimens by sweeping in interior of swamp; Sept. 2, 1910, sweeping, I.

15153 *Oberea ruficollis* (Fab.). July 4, 1911, swept from low vegetation, IX. (W. J. Gerhard).

CHRYSOMELIDAE

15240 *Lema palustris* Blatch. July 30, 1911, VI, taken by sweeping as were all other specimens of this family unless otherwise noted. This species was described from specimens taken by "Sweeping herbage in tamarack swamps of northern third of state" but it is the common species erroneously called *brunnicollis*, the real *brunnicollis* as correctly identified by Blatchley is found only in Florida.

15267 *Coscinoptera dominicana* (Fab.). July 4, 1911, XI.

15369 *Pachybrachys femoratus* (Oliv.)? July 4, 1911, VI. (H. C. Fall, in litt.). "One ♀ very near what I call *femoratus* but the eyes are too approximate. ♂ needed."

15393 *Pachybrachys peccans* Suffr. July 4, 1911, two specimens, VII. (Det. H. C. Fall).

15414 *Pachybrachys spumarius* Suffr.? July 4, 1911, seven specimens, X. (H. C. Fall, in litt., "This Bowditch calls *spumarius*. I am not yet satisfied as to whether it is the true *spumarius*—so I think I shall attach a '?' to it"). Ind. - N. C. Ala.

15432 *Pachybrachys tridens* (Melsh.). July 4, 1911, two specimens, IX. (H. C. Fall, in litt., "Not the typical form but, I think, not specifically distinct").

15470 *Pachybrachys hepaticus* (Melsh.). July 4, 1911, three specimens, VII.

15472 *Monachulus ater* (Hald.). Sept. 1, 1925, five specimens, sweeping on quaking bog.

15473 *Monachulus saponatus* (Fab.). July 4, 1911, two specimens, VII; July 30, 1911, two specimens, X; Aug. 15, 1920, many seen throughout swamp.

15480 *Cryptocephalus quadruplex* Newm. July 4, 1911, I.

15495 *Cryptocephalus venustus* Fab. July 4, 1911, four specimens, XI, XXIV.

15495a *Cryptocephalus venustus* Fab. var. *cinctipennis* Rand. July 4, 1911, two specimens, XXII. Ind. Conn.

15503 *Cryptocephalus trivittatus* Oliv. July 4, 1911, two specimens, VII.

15507 *Cryptocephalus mutabilis* Melsh. July 4, 1911, three specimens, VI, XI; Sept. 5, 1911, X.

15521 *Diachus auratus* (Fab.). July 4, 1911, VII; (Det. H. C. Fall); July 30, 1911, XIV; Sept. 11, 1911, X;

Aug. 15, 1920, XI; Sept. 5, 1920, on elderberry (*Sambucus canadensis*), II; Sept. 1, 1925, sweeping on quaking bog.

15527 *Diachus catarius* (Suffr.). July 30, 1911, XXIII. Ind. Ill. Va.

*15534c *Bassareus mammifer* (Newm.) var. *pretiosus* (Melsh.). Aug. 15, 1920, XI; Sept. 1, 1925, sweeping on quaking bog.

15555a *Colaspis brunnea* (Fab.) var. *costipennis* Cr. July 4, 1911, four specimens, V; Aug. 15, 1920, XV. Fla.

15555b *Colaspis brunnea* (Fab.) var. *flavida* Say. July 30, 1911, VI.

15567 *Graphops pubescens* (Melsh.). July 4, 1911, four specimens, X; July 30, 1911, VIII; Sept. 10, 1911, III.

15604b *Adoxus obscurus* (Linn.) var. *villosulus* Schrank. July 4, 1911, III. *Vitis* auct, nec Fab., is a synonym. Hamilton writes, "*Vitis* is the form from Lake Superior eastward" and also, "Var. *vitis* is the Canadian form."

15626c *Paria canella* (Fab.) var. *pumila* Lec. July 4, 1911, beaten from alder, IV.

15639 *Labidomera clivicollis* (Kirby). Sept. 10, 1911, XIII.

15665 *Calligrapha similis* Rogers. Sept. 10, 1911, XI.

15677 *Calligrapha bigsbyana* (Kirby). Sept. 9, 1909, "Tamarack, off maple leaf, young tamaracks near edge" (V. E. Shelford). Ind. Mo. - Can. Ore.

15688 *Chrysomela auripennis* Say. Sept. 10, 1911, XII. Ind. south and west.

15750 *Galerucella notata* (Fab.). July 30, 1911, eight specimens, VI.

15769 *Diabrotica duodecimpunctata* (Fab.). Aug. 20, 1911, III; Sept. 16, 1911, two specimens, XVIII; Sept.

1-3, 1925, five specimens, sweeping in maple and tamarack zones.

15782 *Diabrotica vittata* (Fab.). Aug. 20, 1911, III; Sept. 11, 1911, two specimens, II; Sept. 16, 1911, five specimens, VII, XVI; Sept. 15, 1911, eight specimens, III; May 13, 1920, XI; Sept. 1-3, 1925, eleven specimens, sweeping in maple zone.

15788 *Phyllobrotica decorata* (Say). July, 4, 1911, IV, IX.

15794 *Phyllobrotica limbata* (Fab.). June 4, 1911, V; June 10, 1922, a male on leaf of a low shrub, XIII.

15886 *Oedionychis limbalis* Melsh. July 30, 1911, VII.

15920 *Altica ignita* Illig. Aug. 15, 1920, XII.

*15926 *Altica litigata* Fall (?). Sept. 1, 1925, three specimens, sweeping on quaking bog. Fla.

15950 *Altica knabi* Blatch. July 4, 1911, abundant, I; Sept. 10, 1911, five specimens, I, IV, X. Described from Lake and Starke counties, Indiana; no other records known to us.

15974 *Crepidodera atriventris* Melsh. May 4, 1912, "Tamarack Swamp, on shrubs in Birch-Maple Zone" (V. E. Shelford).

16043? *Longitarsus rubidus* Lec., or n. sp. July 4, 1916, "Weeds, edge of woods" (B. F. Fulton). Blatchley, in litt., Nov. 3, 1920; "*Longitarsus* either Leconte's *rubidus* or a n. sp. Horn makes *rubidus* a synonym of *alternatus* Zieg., but Fall says the two are distinct."

16074 *Phyllotreta bipustulata* (Fab.). July 4, 1911, XI.

16105 *Anoplitis inaequalis* (Web.). May 30, 1910, "Tamarack Forest. Sweeping under-growth beneath medium sized tamaracks," (V. E. Shelford); July 30, 1911, thirteen specimens, I-XI, many specimens of this lot are so pale in color,—having the upper surface almost entirely yellow, the black markings be-

ing so greatly reduced or in great part wanting,—that at first sight sight they appear to be quite different from *inaequalis;* Sept. 10, 1911, four specimens, III; Aug. 20, 1911, three specimens, VII, XVI; Sept. 15, 1911, four specimens, V; May 31, 1920, VII; Sept. 2, 1925, nine specimens, sweeping in maple zone.

16157 *Metriona bicolor* (Fab.). May 4, 1912, "From shrubs at forest margin of bog," (V. E. Shelford).

MYLABRIDAE

*16190 *Mylabris nigrinus* Horn. Sept. 2, 1910, sweeping low vegetation, XI. M. St. Conn. N. Y.

CURCULIONIDAE

16348 *Rhynchites bicolor* Fab. July 4, 1911, sweeping VII.

16392 *Apion pennsylvanicum* Boh. Sept. 2, 1925, sweeping in maple zone.

16423 *Apion walshi* Smith. Sept. 3, 1925, sweeping in maple zone.

16457 *Apion segnipes* Say. July 4, 1910, six specimens, July 4, 1911, all by sweeping at bog margin, VII. (Det. H. C. Fall).

16548 *Anametis setosus* Blatch. Sept. 2, 1925, sweeping in maple zone. Described from Lake, Vigo and Posey Counties, Indiana; also recorded from Mo.

16678 *Otiorhynchus ovatus* (Linn.). Sept. 12, 1920, sifting damp leaves, X.

16721 *Aphrastus taeniatus* Gyll. A number of specimens emerged on Aug. 27, 1920, and on several days following from trunks of sassafras shrubs gathered at swamp, III; Aug. 12, 1920. (H. L. Stoddard).

16738 *Sitona tibialis* Hbst. Sept. 2, 1910, sweeping, IX. (W. J. Gerhard).

16754 *Hypera punctata* (Fab.). Sept. 12, 1911, sifted from sphagnum moss, X; July 4, 1911, four specimens from leaves of pitcher plant, near VII.

16765 *Phytonomus nigrirostris* (Fab.). Sept. 1, 1925, sweeping in maple zone.

*16776 *Listronotus callosus* Lec. May 4, 1912, "Dead in Pitcher plant leaves" (V. E. Shelford). Ont. - Ga. La.

16778 *Listronotus inaequalipennis* (Boh.). May 13, 1910, "Open bog, on vegetation" (V. E. Shelford).

16821 *Hyperodes sparsus* (Say). July 4, 1913, sweeping, V. (Det. W. S. Blatchley).

*16874 *Hylobius confusus* Kirby. July 4, 1911, VII; July 30, 1911, two specimens; Sept. 10, 1911, II; all taken by sweeping. Lab. N. S. - Ala., N. Y. Mass. Mich.

17012 *Brachybamus electus* Germ. May 30, 1910, two specimens, "Open bog" and July 4, 1912, "Sweeping, open bog," (V. E. Shelford).

17019 *Endalus ovalis* Lec. July 24, 1916, two specimens, "Weeds, edge of woods" and "open bog." (B. B. Fulton).

17068 *Plocetes ulmi* Lec. May 31, 1920, seven specimens beaten from boughs of dead maple and alder, IV. (W. J. Gerhard, Emil Liljeblad and Wolcott).

17121 *Otidocephalus chevrolati* Horn. July 4, 1911, sweeping, XI.

17159 *Balaninus nasicus* Say. July 4, 1911, sweeping, XIV.

*17228 *Anthonomus simiolus* Blatch. Aug. 15, 1920, sweeping beneath tamaracks, XVIII. Tyngsboro, Mass., the type locality, is apparently the only previous record.

—— *Pseudathonomus* sp. Sept. 2, 1925, sweeping in maple zone.

*17341 *Orchestes illinoisensis* Fall. Aug. 15, 1920, sweeping, IX. Described from northern Illinois; no other records have been found.

17351 *Acalyptus carpini* (Hbst.). July 6, 1913, common on

flowers, IV; July 4, 1911, sweeping low vegetation, VII.

17360 *Miarus hispidulus* Lec. Sept. 2, 1910, sweeping, I.

17489 *Baris confinis* (Lec.). May, "taken on vegetation on open bog," (V. E. Shelford). Sept. 2, 1910, two specimens beaten from tamarack boughs, VI.

17542 *Madarellus undulatus* (Say.). Sept. 10, 1910, two specimens swept from undergrowth, XVII; Sept. 4, 1925, three specimens, sweeping in tamarack zone.

17561 *Pseudobaris angusta* (Lec.). Sept. 2, 1910, sweeping, VII.

17686 *Barilepton quadricolle* Lec. May 30, 1910, two specimens, "Tamarack, - open bog" (V. E. Shelford). (Det. verified by W. S. Blatchley).

17719 *Cylindrocopturus quercus* (Say). July 4, 1911, sweeping low vegetation, VI. (Det. W. S. Blatchley).

17753 *Auleutes nebulosus* Lec. Sept. 1, 1925, three specimens, sweeping on quaking bog.

17820 *Ceutorhynchus zimmermanni* Gyll. July 4, 1910, sweeping, VII, (Det. H. C. Fall).

17823 *Dietzella lituratus* Dietz. Aug. 15, 1920, sweeping, XV, XIV. Ind. Ill. - Mass. N. H. Can.

17828 *Pelenomus sulcicollis* (Fahr.). July 4, 1911, three specimens, VII; July 30, 1911, eight specimens, I-XI; Aug. 20, 1911, VII; (Det. H. C. Fall), Sept. 11, 1911, II; Aug. 15, 1920, VIII, IX, XI, XV;Sept. 5, 1920, XV: all by sweeping.

17841 *Rhinoncus pericarpius* (Fab.). July 4, 1911, sweeping, six specimens, III, VII, VIII, XI.

17842 *Rhinoncus pyrrhopus* Boh. July 4, 1910, two specimens by sweeping, VI.

17890 *Conotrachelus anaglypticus* (Say). July 4, 1911, VI;

July 30, 1911, five specimens beaten from boughs of young tamarack, VII, (W. J. Gerhard); Aug. 20, 1911, three specimens, VII; Sept. 2, 1910, VIII; Sept. 10, 1911, three, III; Sept. 15, 1911, four, II; Sept. 16, 1911, VII; Sept. 26, 1920, sifted from damp leaves, X; May 31, 1920, on ferns, V. All, not otherwise noted, were taken by sweeping.

17919 *Tyloderma foveolata* Say. July 4, 1911, two specimens by sweeping, VII.

17928a *Tyloderma nigra* Csy. July 3, 1911, at light, II; July 4, 1911, two specimens, VII Ind. Ill. N. J.

*17974 *Cryptorhynchus lapathi* (Linn.). Sept. 2, 1925, taken from leaf of pitcher plant on quaking bog. Sib. Eur. Me. Dak. D. C. N. J. N. Y.

17980 *Cryptorhynchus obtentus* (Hbst.). July 4, 1911, clinging to bark on dying tamarack tree, VIII. Ill. N. Y. - La. Fla.

18031 *Cossonus impressifrons* Boh. Sept. 10, 1911, under bark of white pine tree, III.

18035 *Cossonus corticola* Say. July 30, 1911, and Sept. 10, 1911, seven specimens, beneath bark of white pine tree, III; Aug. 20, 1911, eight specimens beneath bark of dying white pine, VII.

18087 *Rhodobaenus tredecimpunctatus* (Ill.). July 4, 1911, V; Sept. 10, 1911, XII; both taken by sweeping.

18141 *Sphenophorus venatus* (Say). June 25, 1921, sifted from sphagnum moss, V. (Det. W. S. Blatchley).

SCOLYTIDAE

18174 *Scolytus piceae* (Swaine). Aug. 15, 1920, sweeping ferns (*Osmunda cinnamonea* L.) beneath tamaracks, IX. "E. Can. E. U. S. Me. No. N. Y. Distribution more northern. Specimens from near Buffalo, N. Y., are most southern I have seen." W. M. Blackman (in Litt.).

18193 *Polygraphus rufipennis* (Kirby). Sept. 9, 1909, several specimens, "Dead tamaracks in early stage of decay and partly dead trees" (V. E. Shelford). (Det. H. C. Fall); May 4, 1912, two specimens in "Dead tamaracks, early state of decay" (V. E. Shelford); May 5, 1915, five specimens under bark of tamarack log, V; July 30, 1911, six specimens under bark of dead tamarack tree, VII, (W. J. Gerhard); Sept. 2, 1925, thirty-four specimens beneath bark of fallen tamarack tree.

*18193 *Polygraphus nigriceps* (Kirby). May 31, 1920, VI, (W. J. Gerhard). This specimen fits perfectly the description of *nigriceps*, the type of which was taken from Lat. 65°; the present specimen is 2 mm., in length, the color as given,—the rufus, the head black—and the rows of punctures of the elytra are much less distinct than those of *rufipennis*. In recognizing this as a valid species doubt is thrown on the recorded distribution of *rufipennis* as the specimens recorded may have been either of the two species. My specimens of *rufipennis* all agree in having coarser, larger, more distinct elytral punctures and in being of large size. Nfld.

*18221 *Dendroctonus simplex* Lec. July 30, 1911, three specimens, (Det. H. C. Fall), and Aug. 20, 1911, dead beneath bark of tamarack tree, VII; May 30, 1910, "Tamarack - Pine Zone," (V. E. Shelford); May 9, 1919, twenty specimens under bark of fallen tamarack sapling, VI; Sept. 5, 1920, four specimens beneath bark of dying tamarack tree, IV; Sept. 2, 1925, three specimens, dead under bark of fallen and decaying tamarack log. Ind. W. Va. - Can. Alas.

18267 *Hylurgops pinifex* (Fitch). Sept. 10, 1911, in a gallery in bark of large, dead white pine, III (Det. H. C. Fall). Ind. N.J. - Can.

*18400 *Gnathotrichus materiarius* (Fitch). July 30, 1911, beneath bark of pine tree, VII (W. J. Gerhard)

(Det. H. C. Fall); Aug. 20, 1911, two specimens under bark of pine, VIII.

*18455 *Pityogenes hopkinsi* Swaine. Sept. 2, 1925, two specimens, beneath bark of fallen tamarack tree, about four inches in diameter, in western portion of swamp; Sept. 3, 1925, nineteen specimens, beneath bark of decaying pine branch. With the specimens taken Sept. 2 were found one specimen of *Corticaria ferruginea*, 34 of *Polygraphus rufipennis*, 12 of *Ips cacographus*, four of *I. pini* and 12 of *Orthotomicus caelatus*. E. Can. E. U. S.

*18462 *Ips calligraphus* (Germ.). July 30, 1911, and Aug. 20, 1911, abundant, all stages—larvae, pupae, freshly transformed and fully colored adults, beneath bark of large white pine, VII; Sept. 5, 1920, abundant in large pine (about 15 inches in diameter), XIV. Attention was attracted to this tree by the frass and exuding pitch. In some cases adults were just entering the bark, although most of the galleries were three to seven inches in length; two galleries about equal in length, ten and twelve inches respectively, running parallel to each other separated by a distince varying from one-sixteenth to one-eighth of an inch, and opening into a common chamber at the upper end, were found. The galleries were found over a space of more than ten feet, beginning about fourteen inches above the roots. The bark of this tree was green and clung very tenaciously to the wood, although one of the two branches into which the tree was divided at a height of twelve feet was dead. Pine producing regions of U. S. and Can.

*18463 *Ips cacographus* Zimm. See no. 18455 above.

18463 *Ips grandicollis* (Eich.). Aug. 20, 1911, three specimens taken with the specimens of *I. calligraphus* of this date, although those of this species were found at a distance of only six to ten inches from the sur-

face of the swamp. *Hister basalis, H. coarctatus, Plegaderus transversus, Metabletus americanus,* and *Cossonis corticola* were associated with these two species. May 9, 1915, two specimens beneath bark of tamarack sapling, V.

*18473 *Ips perturbatus* (Eich.). Sept. 11, 1911, dead beneath bark of white pine tree, III (Det. H. C. Fall). Mich. Nfld. Hudson Bay, Alas. Utah. ("Distribution much more northerly," W. M. Blackman, in litt.)

*18475 *Ips pini* (Say). Sept. 2, 1925, four specimens, with no. 18455 of this date—see above. Alas. Can. E. U. S.

*18492 *Orthotomicus caelatus* (Eich.). July 30, 1911, five specimens beneath bark of pine tree, III, May 30, 1910, six specimens, "Pine-Tamarack zone" (V. E. Shelford); May 9, 1915, forty specimens beneath bark of fallen dead pine sapling, IV; Sept. 2, 1925, twelve specimens—see no. 18455 above. Can. U. S. south to W. Va.

18538 *Dryocoetes americanus* Hopk. May 31, 1920, two specimens beaten from terminal branches of fallen dead tamarack trees, IV.

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BIBLIOGRAPHY

Adams, Chas. C. 1908. Isle Royale Survey. Mich. Survey 1908.

Blatchley, W. S. 1910. The Coleoptera of Indiana. Ind. Dept. Geol. Nat Res., Bull. 1. 1386 pp.

Blatchley, W. S., and *Leng, Chas. W.* 1916. Rhynchophora of N. E. America. Indianapolis. 682 pp.

Bowditch, Fred C. 1896. List of Mt. Washington Coleoptera. Psyche, Suppl. II: 1-11.

Casey, Thomas L. 1910-1918. Memoirs on the Coleoptera, I-VIII. Lancaster.

Felt, E. P. 1905-1906. Insects affecting Park and Woodland Trees. Mem. N. Y. St. Mus. VIII, parts 1-2. 877 pp.

Hamilton, John. 1894. Catalogue of Coleoptera common to N. America, Asia and Europe. Trans. Amer. Ent. Soc., Vol. 21: 345-416.

Hatch, M. H. 1924. A List of Coleoptera from Charlevoix County, Michigan. Papers Mich. Acad. Sci., Arts and Lett., Vol. 4: 543-586.

1928. A Geographical Index of the Catalogues and Local lists of Nearctic Coleoptera. Jr. N. Y. Ent. Soc., Vol. 36: 335-354.

Hubbard, H. G. and *Schwartz, E. A.* 1878. The Coleoptera of Michigan, Lake Superior. Proc. Amer. Phil. Soc., Vol. 17: 627-643.

LeConte, John L. 1850. General remarks on Coleoptera. Agassiz's Lake Superior. Boston. Vol. 4: 201-242.

Lyon, M. W., Jr. 1927. List of Flowering Plants and Ferns in the Dunes State Park and Vicinity, Porter County, Indiana. Amer. Midl. Nat., Vol. 10 (8-9): 245-295.

1930. List of Flowering Plants and Ferns in the Dunes State Park and Vicinity, Indiana-Supplement. Amer. Midl. Nat., Vol. 12 (2): 33-43.

Peattie, D. C. 1930. Flora of the Indiana Dunes. Field Mus. Nat. Hist. 432 pp.

Pepoon, H. S. 1927. Annotated flora of the Chicago region. Chicago Acad. Sci. 221-554 pp.

Sherman, John D., Jr. 1910. A list of Laborador Coleoptera. Jr. N. Y. Ent. Soc., Vol. 18: 173-197.

Snow, Francis H. 1877. List of Coleoptera collected in Colorado. Kan. Collegiate, Vol. 2: 4-6.

1885. Lists of Coleoptera of New Mexico. Trans. Kan. Acad. Sci., Vol. 9: 65-69.

Timberlake, P. H. 1919. Notes on the North American species of Hippodamia. Jr. N. Y. Ent. Soc., Vol. 27: 162-174.

Van Dyke, Edwin C. 1918. A Review of Silis. Jr. N. Y. Ent. Soc., Vol. 26: 161-179.

Wickham, H. F. 1895. A List of Coleoptera from the Southern Shore of Lake Superior. Proc. Davenport Acad. Nat. Sci., Vol. 6: 125-169.

Wolcott, A. B. 1895. Coleoptera of Central Illinois. Ent. News, Vol. 6 (10): 309-310.

1896. Coleoptera of Central Illinois—No. II. Ent. News, Vol. 7 (8): 234-238.

A COLLECTION OF AMPHIBIANS AND REPTILES FROM SOUTHERN MISSOURI

CHARLES E. BURT

On June 2-3, 1932, while I was enroute from Kansas to Tennessee, I took the opportunity to collect a series of amphibians and reptiles in southern Missouri. United States Highway No. 66 was traversed from the Kansas line west of Joplin to Springfield, and Highway No. 60 was followed from Springfield to the Mississippi River just below Cairo, Illinois. The collection reported here was made as part of a cooperative project with the United States National Museum, and the specimens involved have been catalogued at that institution under the numbers indicated below.

SALAMANDERS

Triturus viridescens viridescens (Rafinesque)

A newt (No. 85668), taken from pond scum in a sylvan pool two miles southeast of Willow Springs, Howell County, had no red spots on the sides and tail, being like the southern subspecies described as *meridionalis* in this regard. There is an apparent need for a careful systematic revision of this group.

TOADS

Bufo fowleri Hinckley

One of these toads (No. 85561) was found in the grass growing at the end of a shallow pond two miles west of Fordland, Webster County, and another (No. 85560) was found in a similar situation near a stream four miles east of Norwood, Wright County.

FROGS

Acris gryllus (Le Conte)

Cricket-frogs were obtained near small ponds two miles south-east of Willow Springs, Howell Couunty (Nos. 85599-600); five miles west of Birch Tree, Shannon County (No.

85595); and two miles west of Fordland, Webster County (Nos. 85596-98).

Pseudacris triseriata triseriata (Wied)

These little swamp frogs (Nos. 85585-86) were singing as they clung to grass stems that were rising above the temporarily submerged edge of a pond two miles west of Fordland, Webster County, on the night of June 2.

Hyla crucifera Wied

Singing adults of this species (Nos. 85604-606) were taken at the same time as the *Pseudacris* frogs mentioned above.

Hyla versicolor versicolor (Le Conte)

Singing tree-frogs (Nos. 85580-82) were collected at the same place as the *Pseudacris t. triseriata* and *Hyla crucifera* frogs just listed.

Rana catesbeiana Shaw

Bullfrogs were obtained near permanent ponds two miles south-east of Willow Springs, Howell County (No. 85545); and two miles west of Fordland, Webster County (Nos. 85546-47).

Rana pipiens Schreber

Two leopard frogs (Nos. 85591-92) were captured in the pond two miles west of Fordland, Webster County.

LIZARDS

Sceloporus undulatus undulatus (Latreille)

Eastern spiny swifts were seen on stumps, piles of posts, brush heaps, and rocks at various places. Specimens were taken six miles northeast of Van Buren, Carter County (Nos. 85489-90); four miles southwest of Rogersville, in Greene County (No. 85488); one mile west of Winona, Shannon County (No. 85491); and five miles west of Mansfield, Wright County (No. 85492).

Cnemidophorus sexlineatus sexlineatus (Linnaeus)

A six-lined racerunner (No. 85482) was captured while it

was foraging for food in a clump of high weeds above a stream four miles east of Norwood, Wright County.

Eumeces fasciatus (Linnaeus)

During a short shower, a moderate sized five-lined skink (No. 85480) was located under the loose bark of a fallen log five miles west of Mountain View, Howell County. There were 31 scale rows (at the middle of the body), two postmentals. and two postnasal.

SNAKES

Heterodon contortrix (Linnaeus)

A hog-nosed snake (No. 85532) was picked from the road in a hilly, wooded region two miles east of Norwood, Wright County, shortly after it had been injured by a passing automobile.

Coluber constrictor flaviventris (Say)

Blue-racer snakes were observed or collected four miles southeast of Willow Springs, Howell County; at Phelps, Lawrence County; along Beeler Creek, two miles east of Cabool, Texas County (No. 85531); and two miles east of Mansfield, Wright County (No. 85530).

Elaphe laeta (Baird and Girard)

An example of this king snake (No. 85540) from three miles east of Mansfield, Wright County, has 27 scale rows at the middle of the body, 212 ventral plates, and 39 dorsal preanal blotches.

Elaphe obsoleta obsoleta (Say)

Blacksnakes were observed on the road two miles east of Mansfield, and at Mountain Grove, in Wright County. The latter example measured 1830 mm. (approximately six feet) in total length.

Pituophis sayi sayi (Schlegel)

Bullsnakes were found in the road three miles west of Arvilla (No. 85497), and four miles east of Carthage, in Jas-

per County. The latter specimen had 56 dorsal blotches, 46 of which were preanal.

Natrix sipedon sipedon (Linnaeus)

These water snakes (Nos. 85504-505) were collected at night, with the aid of headlights, about the shallow edge of a side pool from a large pond two miles west of Fordland, Webster County, where grass-tops were appearing above the water. Here many frogs were congregated (see above records for several species) and it is probable that at least some of the forms are regular items in the diet of this watersnake.

TURTLES

Records of the turtles in the present collection will appear in a subsequent monograph by Dr Leonhard Stejneger. The following reports are from the observation of dead specimens in the road, these examples being too badly crushed or decayed to be preserved.

Chelydra serpentina (Linnaeus)

A large snapping turtle was seen at Phelps, Lawrence County.

Terrapene carolina triunguis (Agassiz)

These turtles were observed one mile east of Poplar Bluff, Butler County; three miles east of Rogersville, Webster County; and three and one-half miles west of Mansfield, Wright County.

Terrapene ornata (Agassiz)

This common box-turtle was observed three miles west of Arvilla, and three miles west of Carthage, in Jasper County; and at Rescue, in Lawrence County.

SOUTHWESTERN COLLEGE,
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FORAMINIFERA FROM THE JURASSIC IN MONTANA

JOHN R. SANDIDGE

During the summer of 1932, as a part of the research program of the Princeton Geological Expedition to Montana, under the direction of Professor W. T. Thom, a stratigraphic section was measured in an undescribed area of the Big Horn Basin immediately west of the Pryor Mountains. A line was run by plane table across the strike of the outcropping strata from a point about two miles west of Bowler Post Office to the section house at Wade Siding, on the C. B. & Q. R. R., and southwestward for a distance of one and a third miles. The location of the section is shown in Figure 1. The plane table work was carried on under the supervision of Professor C. W. Wilson, of Vanderbilt University, with the assistance of student members of the expedition. The stratigraphy was worked out by the author with the assistance of Professor Wilson, and students.

The section starts at the base of the Triassic, Chugwater formation, and extends across this formation; the Jurassic, Sundance and Morrison formations; the Cretaceous, Cloverly formation; the Colorado Group, and to the base of the Eagle sandstone in the Montana Group, of Upper Cretaceous age. Fossils were collected, and samples of the clays and shales were taken at frequent intervals throughout the section. The succession of beds is shown in Figure 2.

The total thickness of the Sundance measured in this section is approximately 510 feet, with lithology as shown in Figure 3. Foraminifera were found in the grayish green shale which occurs between the limestone beds in the lower part of the formation, below the red sediments; in the upper portion of the formation in the lower part of the olive-green clay which bears *Gryphea calceola* var. *nebrascensis*, and *Belemnites densus;* and in sandy shale a few inches below the base of the cross bedded sandstone which marks the top of the

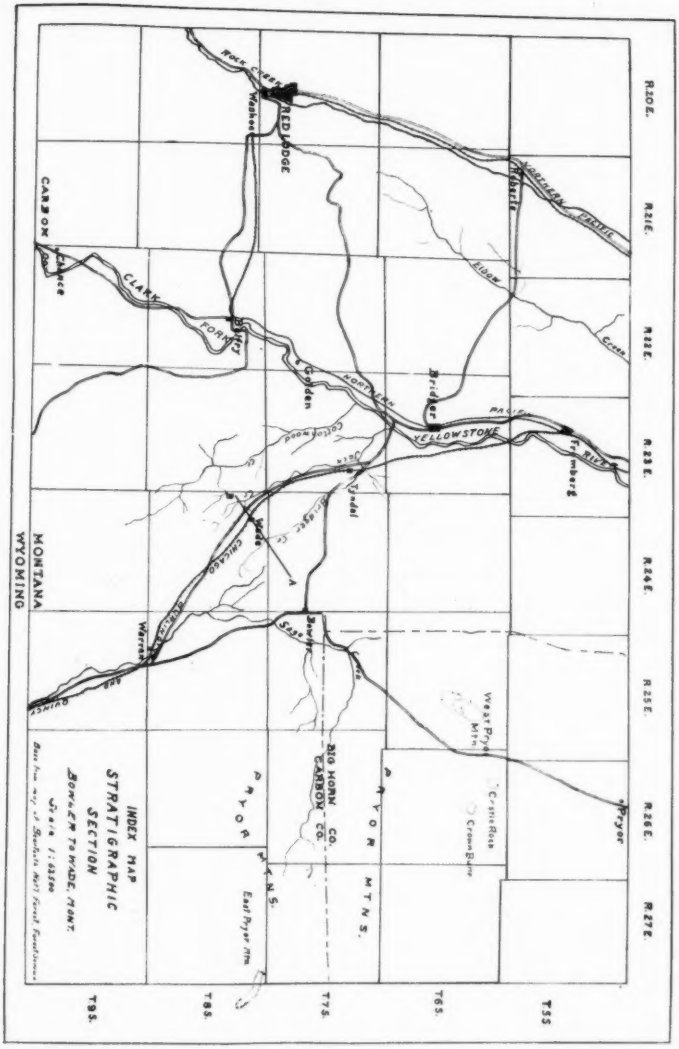


Figure 2. Index Map, showing location of Geologic Section.

Sundance. The columnar section given in Figure 3 shows the position of the foraminiferal zones. These foraminifera are calcareous forms belonging principally to the family *Lagenidae*. *Lenticulina*, *Vaginulina*, and *Frondicularia* are the chief genera represented. Most of the species show relationships with members of a fauna described from the Bajocien (Lower Oolitic) of France by Terquem. In addition to certain foraminifera, there are in the Sundance fauna small gastropods, sponge spicules, and stem segments of the Crinoid genus *Pentacrinus* which closely resembles specimens figured and described by Terquem from the Middle Lias (Domérien, "zone of *Ammonites margaritatus*") of Moselle. While the Sundance fauna has these Lower Jurassic affinities, it appears to be principally Upper Jurassic in its general composition, although a definite stage correlation cannot be attempted until the fauna has been much more thoroughly studied.

In referring a number of the Sundance foraminifera to species named and described by Terquem, and by Terquem and Berthelin, the author recognizes the possibility of error. Terquem's works undoubtedly include several species under a single name in some instances, and in other cases subdivisions of forms have been used which in the light of present knowledge of the foraminifera seem questionable. It is apparent that proper disposition of Terquem's species must await a study of his original collections, if these are now available, or of topotype material. Notwithstanding these facts it is significant that a fauna occurs in the North American Jurassic which corresponds in many respects to the material described by Terquem, and Terquem and Berthelin, from the Jurassic of France. In view of the confused state of the nomenclature of these continental Jurassic forms, the writer has refrained, for the time being, from proposing any new species among the Sundance foraminifera from Montana. The purpose of this paper, therefore, is primarily to record the occurrence of Jurassic foraminifera in Montana, and to point out the similarity of the species to figured specimens from the Jurassic of Europe.

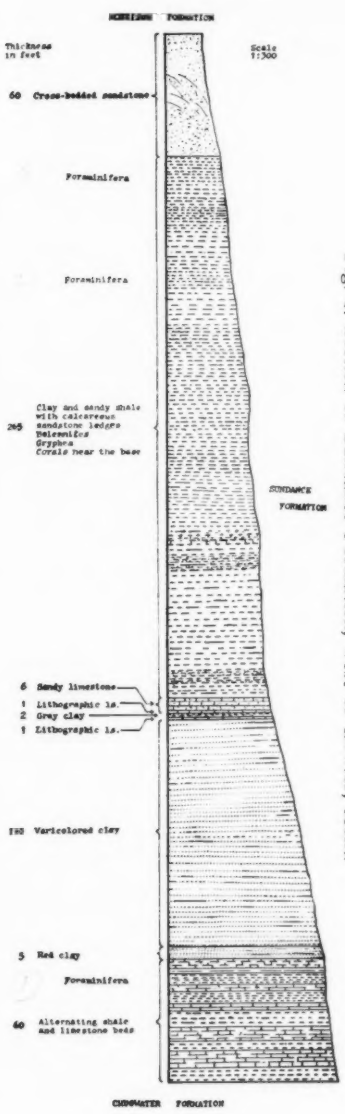


Fig. 3. Section of Sundance Formation, west of Bowler, Mont.

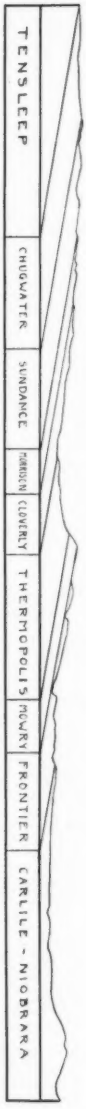


Figure 1. Geologic Section from Bowler to Wade, Mont.

DESCRIPTION OF SPECIES

FORAMINIFERA

Family OPHTHALMIDIIDAE

Genus CORNUSPIRA Schultze

Cornuspira orbicula (Terquem and Berthelin)

Plate I, Fig. 14.

Spirillina orbicula Terquem and Berthelin, Mém. Soc. Géol. de France, 2nd Ser., vol. 10, 1875, p. 17, pl. I, figs. 12, a, b, c.

Description. — Test planispiral, consisting of a long tube closely coiled around a small proloculum, increasing in size toward the outer end; circular in shape, concave toward the center; wall calcareous, smooth; aperture at the end of the tube. Diameter of the figured specimen, 0.38 mm.

Remarks. — *Cornuspira orbicula* is a Liassic species (Domérien). It occurs rarely in the *Gryphea* zone of the Sundance.

Family LAGENIDAE

Genus LENTICULINA Lamarck

Lenticulina helios (Terquem)

Plate I, Figs. 1, 2.

Cristellaria helios Terquem, Mém. Acad. Imp. de Metz, vol. 50, 1868-1869 (1870), p. 445, pl. XVI; figs. 19-21.

Description. — Test slightly elongate, compressed, composed of numerous chambers, a prominent nucleus at the center; chambers regular, arched; sutures marked by prominent, raised, radiating ribs; wall smooth; aperture radial. Length of figured specimen, 0.55 mm.

Remarks. — This species was described by Terquem originally from the Bajocien of Moselle (Lower Oolitic). It occurs abundantly in his material, and is said to be very constant in its form. The species is common in the two upper foraminiferal zones of the Sundance.

Lenticulina mamillaris (Terquem)

Plate I, Figs. 3, 4.

Cristellaria mamillaris Terquem, Mém. Soc. Géol. de France, 3d, Ser., vol. IV, 1886, p. 37, pl. IV, figs. 1-4.

Description. — Test discoidal, inflated, rounded on the periphery, surface smooth and unornamented, covered with clear shell material, a thick umbo at the center; chambers triangular in shape, slightly arched, early coils visible through the transparent walls; aperture round, radial. Diameter of the figured specimen, 0.55 mm.

Remarks. — *Lenticulina mamillaris* was described by Terquem from the Bajocien (Fuller's Earth) near Varsovie. It resembles the very common *Lenticulina rotulata* Lamarck, but differs from that species in having a large deposit of clear shell material over the entire surface, with an especially thick umbo. The form occurs frequently in the two upper zones of the Sundance.

Lenticulina anceps (Terquem)

Plate I, Fig. 9.

Cristellaria anceps Terquem, Mém. Acad. Imp. de Metz, vol. 50, 1868-1869 (1870), p. 428, pl. IX, figs. 11-21; Bull. Soc. Géol. de France, 3d Ser., vol. IV, 1876, p. 492, pl. XVI, fig. 23; Cinquieme Mém. Foram. Oolitique, 1883, p. 350, pl. XXXVIII, figs. 18-28, pl. XXXIX, figs. 1-3.

Description. — Test elongate, compressed, smooth, periphery rounded; chambers oblique, slightly inflated, the later ones projecting over the proloculum; aperture round, radial. Length of the figured specimen, 0.30 mm.

Remark. — Terquem records this species from the Bajocien (Lower Oolitic) of France. It occurs very abundantly at some of his localities, and varies considerably in its detailed form. The species is similarly abundant and variable in the Sundance. It is present in the two upper zones.

Lenticulina sculpta (Terquem and Berthelin)

Plate I, Fig. 10.

Cristellaria sculpta Terquem and Berthelin, Mém. Soc. Géol. de France, 2nd Ser., vol. X, 1875, p. 49, pl. IV, fig. 12.

Description. — Test elongate, compressed, smooth, periphery carinate, inner margin rounded; chambers uncoiling, inflated and raised, as if sculptured, separated by depressed sutures; aperture round, radial. Length of illustrated specimen, 0.50 mm.

Remarks. — Terquem and Berthelin report this species from the Middle Lias ("zone of *Ammonites margaritatus*") where it occurs very rarely. The form occurs sparsely in the *Gryphea* zone of the Sundance.

Genus MARGINULINA d'Orbigny

Marginulina cf. *lacunata* (Terquem)

Plate I, Figs. 6-8.

Cristellaria lacunata Terquem and Berthelin, Mém. Soc. Géol. de France, 2nd Ser., vol. X, 1875, p. 50, pl. IV, figs. 14, a, b.

Description. — Test elongate, sub-cylindrical in transverse section, outer margin carinate, inner margin concave, surface marked by raised longitudinal costae (three on each side, with one larger than the others), rounded at the lower end, pointed at the top; chambers numerous, not visible from the exterior except in very old tests; aperture round, terminal at the peripheral angle. Length of the figured specimens, 0.38, and 0.55 mm.

Marginulina cf. *centralis* (Terquem)

Plate I, Fig. 11.

Cristellaria centralis Terquem, Mém. Acad. Imp de Metz, vol. 50, 1868-1869 (1870), p. 428, pl. XVI, figs. 1-6.

Description. — Test elongate, compressed, smooth, chambers numerous, later ones transverse, sloping, early chambers coiled, proloculum at the center; aperture terminal, round. Length of illustrated specimen, 0.60 mm.

Remarks. — Specimens resembling this species occur abundantly in the two upper foraminiferal zones of the Sundance. Terquem's form was abundant in two zones of the Oolitic at Fontoy.

Genus DENTALINA d'Orbigny

Dentalina propinqua Terquem

Plate I, Fig. 16.

Dentalina propinqua Terquem, Mém. Acad. Imp. de Metz, vol. 51, 1869-1870 (1870), p. 365, pl. XXVIII, figs. 1, 2.

Description. — Test elongate, slightly arcuate, tapering, smooth, consisting of five regular chambers; proloculum spherical, later chambers elongate; sutures straight, transverse; aperture terminal, round. Length of illustrated specimen, 0.58 mm.

Remarks. — This is another species from the Oolitic (Bajocien) of Moselle, where it is rare. It occurs sparsely in the Sundance at the highest foraminiferal horizon.

Genus LINGULINA d'Orbigny

Lingulina dentaliniformis Terquem

Plate I, Fig. 13.

Lingulina dentaliniformis Terquem, Mém. Acad. Imp. de Metz, vol. 51, 1869-1870 (1870), p. 339, pl. XXV, figs. 1-3; Mém. Soc. Géol. de France, 3d Ser., vol. IV, 1886, p. 12, pl. I, figs. 27-29.

Description. — Test elongate, compressed, oval in transverse section, tapering from an obtuse apertural end to a bluntly pointed initial end; chambers in a linear series, 8 in the illustrated specimen; sutures arched; aperture terminal, elongate elliptical. Length of illustrated specimen, 0.80 mm.

Remarks. — This species originally came from the Bajocien of Moselle where it occurs abundantly. It is common in the two upper zones of the Sundance formation.

Genus VAGINULINA d'Orbigny

Vaginulina cf. *disparilis* (Terquem)

Plate I, Fig. 5.

Marginulina disparilis Terquem, Bull. Soc. d'Hist. Nat. Dept. Moselle, 1868, p. 85, pl. IV, figs. 1-24; Terquem and Berthelin, Mém. Soc. Géol. de France, 2nd Ser., vol. X, 1875, p. 57, pl. V, figs. 1a-h.

Description. — Test elongate, greatly compressed, peripheral margin slightly arcuate, inner margin straight; chambers numerous, proloculum oval in shape, later chambers becoming elongate and flattened, extending obliquely from

periphery to inner margin; sutures slightly impressed, oblique; aperture at the peripheral angle, terminal, round. Length of illustrated specimen, 1.75 mm.

Remarks. — This is a species found by Terquem in the Bajocien of Moselle. He has shown it to be a variable form which occurs abundantly in his collections. The species is rare in the Sundance, and occurs only in the highest zones.

Genus FRONDICULARIA Defrance

Frondicularia complanata Defrance

Plate I, Fig. 12.

Frondicularia complanata de France, Dict. Sci. Nat. XXXII, 1824, 178; Atlas, Conch. XIV, 4; H. B. Brady, in Moore "On the Middle and Upper Lias of the Southwest of England," Proc. Somerset Arch. and Nat. Hist. Soc., vol. XIII, 1865-1866 (1867), pl. III, figs. 47, a, b.

Description. — Test elongate, much compressed, tapering gradually from the base of the final chamber to a bluntly rounded proloculum, and rapidly to the aperture; 7 chambers in addition to the proloculum; aperture terminal, round. Length of illustrated specimen, 1.1 mm.

Remarks. — *Frondicularia complanata* is a Liassic species recorded by H. B. Brady from southwestern England. It has been found only in the *Gryphea* zone of the Sundance formation.

Frondicularia nuda Terquem and Berthelin

Plate I, Fig. 15.

Frondicularia nuda Terquem and Berthelin, Mém. Soc. Géol. de France, 2nd Ser., vol. X, 1875, p. 39, pl. III, figs. 9, a, b; Terquem, Mém. Soc. Géol. de France, 3rd Ser., vol. IV, 1886, p. 43, pl. IV, figs. 36, 37.

Description. — Test elongate, compressed, spatulate, slightly depressed along the axis, margin sharp; chambers numerous, flat, regular, chevron shaped; sutures slightly depressed; proloculum spherical; aperture terminal, round. Length of illustrated specimen, 0.45 mm.

Remarks. — This species was described by Terquem and Berthelin from the Lias of France, and later was recorded by Terquem from the Bajocien (Fuller's Earth) near Varsovie. It occurs frequently in the two upper zones of the Sundance formation.

MISCELLANEOUS FOSSILS

Scalaria cf. *liasinus* Quinstadt

Plate I, Fig. 17.

Scalaria liasinus Terquem and Berthelin, Mém. Soc. Géol. de France, 2nd Ser., vol. X, 1875, p. 94, pl. VIII, fig. 15.

This minute gastropod, reported from the Middle Lias of France, occurs in the lowest of the foraminiferal zones of the Sundance. Length of figured specimen, 2.8 mm.

Spicules of an Echinoderm

Plate I, Fig. 18.

Spicules de tube ambulacaire de Radiaires. Terquem Mém. Soc. Géol. de France, 2nd Ser., vol. 1875, p. 109, pl. IX, figs. 9 a-f.

Minute calcareous rods with loops at the ends have been found in the Lias of France, and were regarded as fragments of an echinoderm by Terquem. Identical fragments occur abundantly in the upper foraminiferal zones of the Sundance. Length of figured specimen, 0.50 mm.

Plate I, Fig. 19.

Pentacrinus sibteres Munster, Terquem, Mém. Soc. Géol. de France, 2nd Ser., vol. X, 1875, p. 97, pl. VIII, fig. 20.

Fragments of a crinoid stem, undoubtedly of the genus *Pentacrinus*, and somewhat resembling the species, *sibteres*, recorded by Terquem from the Middle Lias of France, occur abundantly in the lower foraminiferal zone of the Sundance formation. Diameter of figured specimen, 3.0 mm.

PRINCETON UNIVERSITY.

PLATE I.

Figs.

1, 2. *Lenticulina helios* (Terquem), x 52.
1. Lateral view. 2. Peripheral view.

3, 4. *Lenticulina mamillaris* (Terquem), x 52.
3. Lateral view. 4. Peripheral view.

5. *Vaginulina* cf. *disparilis* (Terquem), x 17.
Lateral view.

6, 7, 8. *Marginulina* cf. *Lacunata* (Terquem), x 52.
6. An old adult specimen from the side.
7. A young specimen from the inner edge.
8. The same young specimen from the side.

9. *Lenticulina anceps* (Terquem), x 66.
Lateral view.

10. *Lenticulina sculpta* (Terquem and Berthelin), x 57.
Lateral view.

11. *Marginulina* cf. *centralis* (Terquem), x 55.
Lateral view.

12. *Frondicularia complanata* Defrance, x 35.
Lateral view.

13. *Lingulina dentaliniformis* Terquem, x 40.
Lateral view.

14. *Cornuspira orbicula* Terquem and Berthelin, x 40.
Lateral view.

15. *Frondicularia nuda* Terquem and Berthelin, x 31.
Lateral view.

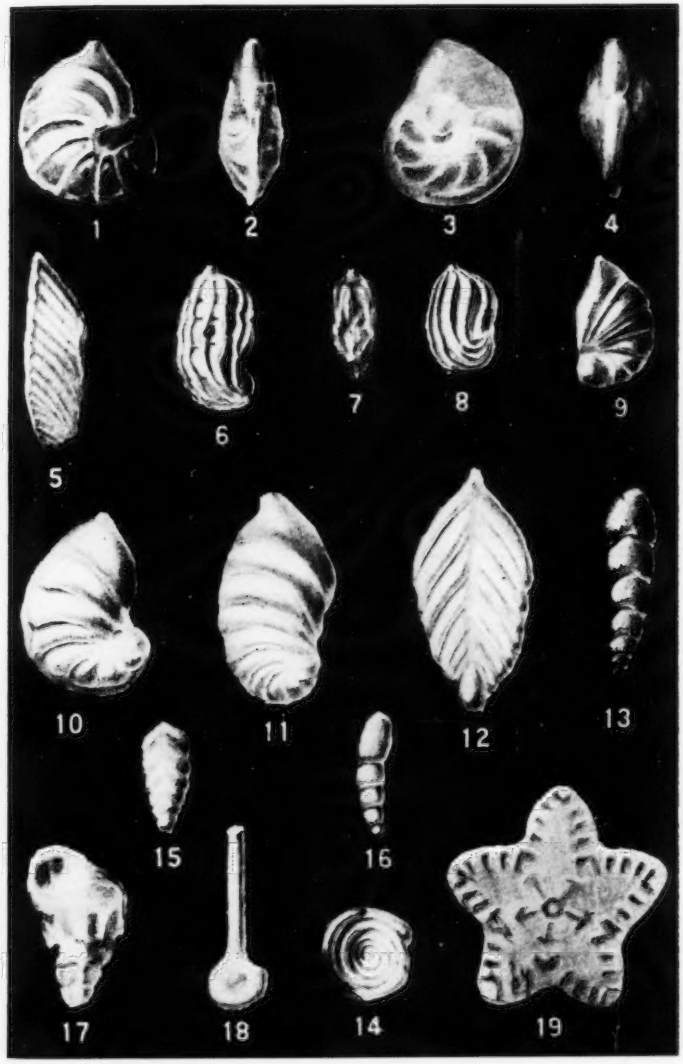
16. *Dentalina propinqua* Terquem, x 33.
Typical specimen from the Sundance.

17. *Scalaria* cf. *liasinus* Terquem, x 10.

18. Spicules of an Echinodern, x 52.

19. *Pentacrinus* sp. *(?)*, x 11.
Section of stem.

PLATE I.



NOTES AND DISCUSSIONS

AN ARTICULATED ANNELID JAW FROM THE DEVONIAN OF NEW YORK

Although many hundreds of single, detached maxillae have been found in Paelozoic rocks, only two articulated jaws of fossil annelids have been recorded, both in a poor state of preservation.

During the summer of 1932, the writer found such a specimen in the Upper Devonian Chemung formation at Alfred Station, Alleghany County, New York. It consists of articulated, asymmetrical, upper proximal paired plates, in an excellent state of preservation.

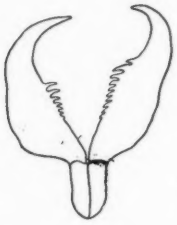


Fig. 1. An articulated annelid jaw of Chemung age. Alfred Station, New York. x 2. 5.

Hinde, in 1879, established the genus *Arabellites*, under which he described many detached fossil jaws of widely differing forms, but with a general resemblance to the existing genus *Arabella* Grube. The accompanying figure illustrates this new Devonian species of *Arabellites*, which will be described fully at a later time.

E. R. Eller.

Carnegie Museum,
Pittsburgh, Pennsylvania.

Bairdia angulata, New Name

In this journal, volume 13, page 262 (September 1932) we described *Bairdia angulata*, n. sp., a Pennsylvanian ostracode from Texas. Since our files show that this name is preoccupied, we wish to substitute for it *Bairdia pennata*, new name, in accordance with the erratum note accompanying the table of contents for volume 13.

H. N. Coryell
Charles Hurst Sample

Columbia University,
New York, N. Y.

A CORRECTION

In my review of *The Invertebrata* by Borradaile and Potts there appears (this journal, vol. 13, p. 411, lines 10-12) the statement that so long as Vermes and equally antiquated phyla stand in paleontologic textbooks, "there is no need for such a book as this, on the desks of those who study fossil invertebrates."

As the entire context indicates, the inclusion of the word *no* is an error. The chief theme of my review is the need for modernization of paleontologic taxonomy, in major and minor groups; and I know of no book so well suited to this purpose as is *The Invertebrata*.

Carroll Lane Fenton.

West Liberty, Iowa.

BOOK REVIEWS

TREATISE ON SEDIMENTATION: By William Twenhofel and Collaborators. Second edition, completely revised. Baltimore: Williams and Wilkins Company, 1932. xxix+926 pp., $8.00.

It is a commonplace that sedimentary rocks have been neglected by petrographers until within comparatively recent years. Even stratigraphers generally have looked upon them as beds to be grouped and correlated, but unworthy of detailed description or analysis. Even the growth of modern sedimentology has not wholly remedied this condition: sections and discussions of areal geology are appearing today in which there is little more attention to sediments themselves than one finds in kindred reports of the 'nineties.' Yet upon the scanty facts which they do contain has been built an imposing—if not wholly impressive—structure of generalization in such fields as paleogeography, paleoecology, and environmental relationships in evolution and dispersal of organisms. Viewing their scanty foundations, one wonders that these generalizations have proved as reliable as they are, and feels no surprise that biologists have hesitated to apply them to the problems presented by existing relationships between organisms and their surroundings. Though the abundant literature cited in this *Treatise* is evidence of great progress on the geologic side, sedimentology still awaits proper recognition in paleontology and biology. It seems proper, therefore, for this review to stress the value of a comprehensive survey of sedimentation to ecology and evolution, as well as to geology proper.

The organization of Dr. Twenhofel's volume (for all but a few sections were written by him, from manuscripts supplied by many collaborators, as well as from his own studies) facilitates such application. Chapters I and II deal with the sources and production of sediments, and with stransportation, deposition and lithification. Though brief, especially in the treatment of lithification, they furnish a useful summary and introduction to the entire subject. Chapter III, dealing with important modifying conditions, contains material for every worker who wishes to know the topographic and climatic relationships of sedimentary records of environments. Especially in dealing with cycles of deposition, and in reconstructing continental conditions from marine formations, is such information essential. Failure to consider it is illustrated by the familiar statement that early Paleozoic continents were barren—even though there is no trace of the great arkoses which should have formed under such conditions.

Chapter IV discusses the modification of sediments by organisms, and the influence upon them of sediments and sedimentary conditions. Plants are very briefly treated, upon a basis set by Professor Berry; animals receive greater attention, with emphasis on modern ecology as

a key to geologic conditions. It is evident, however, that caution must be used to temper this method—and an effort made to discover from enclosing sediments the habits of many fossil animals. Modern muddy bottoms may have few corals—yet in the Hamilton, Hackberry, Richmond and other formations corals are abundant, though the sea floors seem to have been much more muddy than those which accommodated the Devonian sponge colonies of New York. In these same formations are many broad-hinged Protremate and Telotremate brachiopods which seem to have lain directly on the bottom, or which anchored themselves to it by boring pedicels. Comparative data alone would assign them habits comparable to those of the modern *Terebratalia*, which they almost certainly lacked. Like caution should be employed in judging the habits of Eurypterida, in spite of Miss O'Connell's conclusion that most of them dwelt in fresh water.

Chapter V, "Products of Sedimentation," returns to stratified rocks themselves, as the results of organic and inorganic processes of deposition. Since it includes 416 pages—almost half of the book—only a few isolated comments may be made upon it. Some readers doubtless will wish to review Wentworth's section on coarse clastics in view of recent contributions by Wadell (Journal of Geology, vol. 40, pp. 443-451, 1932); the present one would have welcomed further information on the extent and significance of intraformational conglomerates, and upon the "storm rollers" which are found in sandy shales and argillites of the Belt, Medina, Chemung and other formations. Apparently they are not to be homologized with either the clay balls of Haas or the "clay galls" of Twenhofel, but do resemble plastic lumps of mud washed upon portions of the Atlantic coast by storm waves. If the resemblance is valid (and general) they form an important index to disturbances in ancient seas.

In discussing coralline and algal limestones, Twenhofel adopts the terms bioherm and biostrome proposed by Cumings and Shrock. He accepts the organic nature of *Cryptozoon*, *Collenia* and similar forms—and refers to stromatoporoids as "stromatoporoid corals." The real nature of these organisms is of sufficient importance—especially in the formation of biostromes—to justify reference to the work of Twitchell (This Journal, vol. 11, pp. 270-306, 1929), who refers them to the siliceous sponges. That paper also would have prevented an error which appears on page 296, in which Twenhofel follows Grabau in the statement that limestone masses in the White Jura of Swabia were "built largely by calcareous sponges." The only sponge that Grabau mentions is *Cnemidiastrum*—which, in available treatises on zoology, appears as a *siliceous* sponge.

The student of present as well as past environments will find much of value in Chapter VI, on structures, textures and colors of sediments. The section on ripple mark, by Drs. Kindle and Bucher, is the most comprehensive treatment of the subject available, and should stimulate

both observation and experiment. Aridity as a cause of red color in deposits is quite thoroughly discredited, as it should have been long ago. One learns with surprise that hail prints have not been recorded in rocks older than Triassic; perhaps it is appropriate to say here that they are common in some zones of the Belt (Grinnell: Rising Wolf and Rising Bull) of northwestern Montana, and appear also in sandy shales of late Medina (Grimsby?) age in the Niagara gorge. The same Belt deposits containing hail prints have many incomplete mud cracks in which three cracks radiate from a center but do not unite to frame polygons, a situation which Twenhofel characterizes as the exception in nature. It seems probable that less symmetrical markings in the Medina have similar significance.

Chapter VII deals with environments of sedimentation—the inorganic phases of descriptive paleoecology. Though valuable, it would have profited by more thorough citation of examples, and publications in which they are described.

Comparing this with the first edition, many favorable changes are found. Paper and printing are better; pages are larger and more numerous—926 against 661. Figures have been increased from 61 to 121; authors cited from about 700 to 1,200 or more; the index has grown to 24 pages, from an initial 9. These figures, as well as a survey of pages, mean that inadequate passages in the first edition have been greatly expanded, especially in their attention to European researches. Errors in reference and spelling which marred th first edition have been greatly reduced in the second, though footnotes themselves have rached a total of 2252. Great credit is due Miss LeVene and Miss Timm, who edited the manuscript and checked many references. It is a pity, however, that they did not adopt a uniform and reasonable use of "op. cit." A device of limited value at best, it becomes a nuisance when applied to references four and even six pages removed from the page on which it is employed. Note 109, page 640, lists as "op. cit." a reference discovered, after eight minutes' hunt, on page 633. One must doubt whether the slight saving in author's time (there is no real saving in space) justified such inconvenience to readers who will consult the *Treatise* again and again for references to literature.

For the book will be consulted often, by students, teachers and field geologists. Without attaining perfection, it is vastly better than any other work in the field, reviewing subjects that are becoming familiar and pointing the way for research in others that still are scarcely explored. Collaborators, author and publisher are to be congratulated on the production of such a volume at a time when many books are being held from the press, or are making belated appearance in form inferior to that of their predecessors. This edition of Twenhofel's *Treatise* shows improvement in almost every respect, and forms an invaluable contribution to the working equipment of sedimentary, historical and paleontological geology.—CARROLL LANE FENTON.

ECONOMIC MAMMALOGY by Junius Henderson and Elberta L. Craig. Charles C. Thomas, Baltimore and Springfield. 397 pp. $4.50.

This volume is a pioneer of its kind. While there are many books that treat of the economic value of other animals, especially insects, there is none, as far as is known to this reviewer, that gives more than a passing notice to this phase of mammalogy.

The first part of the book, consisting of twenty-eight chapters, is general in nature, while the second part deals specifically with each order of the mammalia. The authors have done their work carefully, if not exhaustively. The foot notes are excellent and a splendid bibliography indicates sources for further study.—F. W.

AN INTRODUCTION TO ZOOLOGY THROUGH THE STUDY OF THE VERTEBRATES WITH SPECIAL REFERENCE TO THE RAT AND MAN, by Zeno Payne Metcalf. pp. 425; illustrations 184. Charles C. Thomas, Springfield and Baltimore. $4.50.

This is a functional course as distinguished from the type or the principles course. The book is well conceived and thoughtfully worked out. The treatment is simple throughout—just the kind of book that should be understandable for the class of students for which it is intended. This reviewer feels that too much ground is covered in the book. He ventures the opinion that the time will come when elementary courses in zoology will confine the treatment of the subject to the elements, leaving out such subjects as evolution, heredity, and the history of zoology. He believes that these subjects cannot be covered with sufficient thoroughness in an elementary course and should be left for special treatment.

Mechanically, this book shows all the characteristic finish that are expected from the Thomas press.—F.W.

LEHRBUCH DER ZOOLOGIE, by Claus-Grobben-Kuehn. 10th edition. pp. 1123 with 1164 illustrations. Julius Springer, Berlin and Vienna. RM : 49,80.

This book is epoch-making in its field. It is a monumental work showing rare judgment in the selection of the material, and ripe scholarship in treatment. This reviewer knows no other text in any language that compares favorably with the *Lehrbuch*. It is the kind of book that no zoologist can afford to disregard. A good quality of paper has been used, the print is clear and the illustrations are all from new plates.

The first eleven chapters are the work of the junior author. Such common topics as the cell, the tissues, and the theory of evolution are here treated in a very uncommon way. The chapter on genetics and on the forms of animals are especially well done. The chapter on em-

bryology has some new plates that aid materially in arriving at clear notions of this difficult subject.

The systematic treatment comprises the second part of the book. This was done by the senior author. A comprehensive and exhaustive knowledge of the subject acquired during a long life of research is here presented in an admirable way. While some, especially Americans, may not agree with the system of classification used in the book, all will be forced to admit that it is based on a logical foundation. Such a basis is only too often lacking in our domestic text books. This is the kind of book that appears but once within the life time of a single man.—F. W.

FORTSCHRITTE DER BOTANIK, herausgegeben von Fritz von Wettstein. Erster Band, Bericht über das Jahr 1931. Berlin, Julius Springer, 1932. vi+263 pp., figs. 16. RM : 18,80.

This new series of which the first volume has recently been issued aims to present in condensed and selected form the essential contributions made in the various fields of botanical investigation. Since the series represents a pioneer effort, the first volume contains also references of the literature of the previous years as a basis for the discussions of current botanical thought.

Sixteen well-known investigators contribute to this volume. This assures reliable and carefully chosen information.

Primarily intended for the use of those engaged in the teaching of scientific botany, the book should prove of assistance to a larger number of botanists and their varying interests. As it often requires considerable time until textbooks are brought "up-to-date" this series should be welcomed by all interested in the rapid progress of the science.

As it differs in more than one respect from such well-known works as Lotsy's *Progressus rei botanicae* and Barton-Wright's *Recent Advances* the reviewer is confident that the series will find its proper place in modern botanical literature.

The book is gotten up in the usual, excellent style of the publisher.—TH. JUST.